SURVEY OF THE OCEAN FISHERIES OFF DELAWARE BAY

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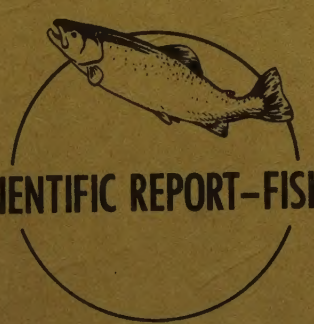

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UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

EXPLANATORY NOTE

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United States Department of the Interior, Fred A. Seaton, Secretary
U. S. Fish and Wildlife Service

SURVEY OF THE OCEAN FISHERIES OFF DELAWARE BAY

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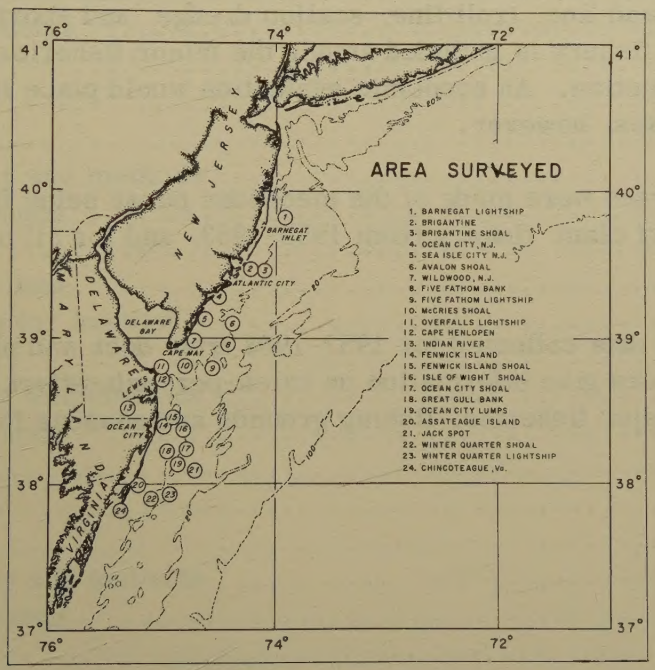

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ABSTRACT

A survey of the ocean fisheries in the region lying between Barnegat and Winter Quarter lightships has furnished detailed information on the fisheries and important fish stocks within the area. Menhaden, otter trawl, and surf clam fisheries account for 98 percent of total production. Miscellaneous minor fisheries include purse seine for foodfish, pot, pound net, drift gill net, trawl line, hand line, troll line, scallop dredge, and sport. The sport or recreational fishery is included among the minor fisheries on the basis of estimated production. An economic evaluation would place it among the three major fisheries, however.

Analyses were made of the menhaden purse seine fishery from 1939-1953, the surf clam fishery from 1950-1953, and for all other fisheries from 1946-1953.

Field data collected for 1952-1953 from dock and plant records and fishing logbooks give information on catch-per-unit-effort and fishing effort for all the major fisheries, fishing grounds and seasons for all fisheries.

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SURVEY OF THE OCEAN FISHERIES OFF DELAWARE BAY

INTRODUCTION

In consideration of the possibility that certain chemical wastes might be discharged at sea, the Fish and Wildlife Service was concerned with the effects of such disposal upon the ocean fishery resources in the vicinity of Delaware Bay. A survey was conducted of the commercial and sport fisheries being prosecuted between Atlantic City, New Jersey and Ocean City, Maryland. The objectives were to determine the following: (1) the fishing areas and seasons, (2) abundance and intensity of fishing in terms of individual species or groups of similar fishes, (3) value of investment and catch, and (4) measures of changes presently occurring in the fisheries which could be compared prior to and following waste disposal.

To these ends, a plan of investigation was outlined, and work commenced in March 1952. Although waste disposal has not been initiated, the collection, tabulation, and analysis of catch records, logbook data, and pertinent information relating to the activities of the ocean fisheries in the vicinity of Delaware Bay have been continued to the present time (1957). The resulting data include measurements of total production, apparent abundance, intensity of fishing, and geographical distribution of the various fish stocks concerned. Comparison of such data from recent years with those of earlier years has provided a measure of the condition of the fisheries. This report summarizes pertinent information through 1953. Data for subsequent years will be presented in supplemental reports.

Information on amounts and species of fish caught by various gears was gathered from many sources, including records of dock, cannery, and processing plant operators, records and published reports of state conservation and research agencies, and records of individual fishermen and wholesale fish dealers. The resulting data represent the most complete compilation of detailed records possible. Data for the earlier years are variously incomplete and these are discussed under each fishery.

Detailed information relating to fishing grounds was gathered by means of a system of logbook records. These were established in the various fleets at the beginning of the fishing seasons in 1952 and are being maintained routinely.

For the purposes of this report, the geographical area considered includes the ocean waters of the Atlantic coast between Barnegat Lightship and Winter Quarter Lightship, seaward to the 100 fathom curve (see fig. 1). It contains roughly 8,500 square nautical miles. The area, in general, delimits the range of the commercial fisheries operating out of southern New Jersey, Delaware, and Maryland ports. In addition, it more or less marks the center of the geographical distribution of migratory fish stocks which range between Cape Cod and Cape Hatteras. It is also the southern limit of commercial fisheries for such species as cod, haddock, lobster, sea scallops, pollock, red hake, sea herring, wolffish, and others. At the same time it is the northern edge of the range for black and red drum, cabio, spot, and other southern species. It is one of the most productive coastal regions in North America. In 1953, the estimated total yield of fish and shellfish from these waters amounted to over 662 million pounds, with an estimated value of $11.5 million to the fishermen. However, this area is capable of producing a great deal more than it does at present. The so-called trash species, for example, are not being utilized, yet the discard of these species amounts to many millions of pounds annually.

Because of the great diversity among the fisheries of the area, a general account of each fishery is presented which includes a brief description of vessels, types of gear employed, methods of operation, seasons of operation, and information concerning yields, and value of the catches. Fishing grounds and measurements of catch and abundance are treated separately under the various fisheries. Estimates of the replacement value of the various fishing fleets are presented in the appendix. A list of common and scientific names of the fish and shellfish treated in the report also is included.

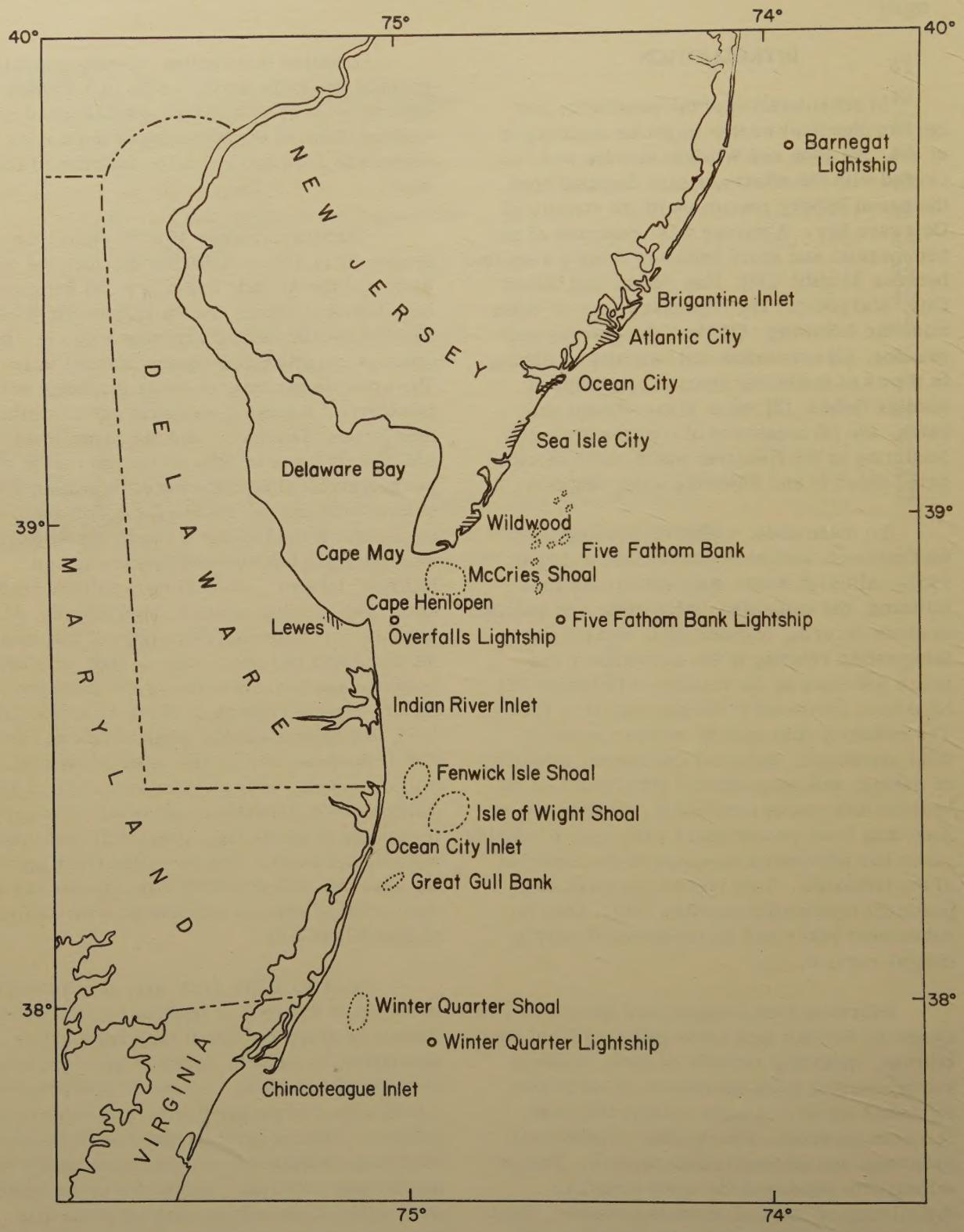

FIGURE 1.--Chart of fishing ports and grounds

SOURCES OF DATA

The catch analyses were based on data consisting of records of deliveries to the landing docks of wholesale fish dealers and processing plants. Except for the offshore otter trawl and scallop dredge, fishing takes place on grounds located within a short distance of the landing dock or plant; each record entry of a vessel's landing, therefore, normally represents a single day's catch. Records of the menhaden purse seine fishery are complete for the period covered. Some of the earlier records of foodfish landings were unavailable due to loss or inaccessibility. Records of otter trawl fishing are about 50 percent complete for 1946 and 1947. In subsequent years, greater amounts of data were available. About 90 percent of the landing records of the inshore fleet were available by 1950 and 98 percent of the offshore landings by 1951. Complete data were impossible to obtain because some docks merely record financial transactions respecting fish landings..

In the menhaden purse seine, otter trawl, and surf clam dredge fisheries, data on fishing areas were obtained from logbooks issued to the fishing captains. They were requested to keep a detailed record of the number of sets or tows, location, and estimated catch for each day's fishing. In addition, menhaden captains were asked the location of each set and whether they were searching for fish or not fishing on days when no catch was recorded. Logbook records were available for approximately 70 percent of the menhaden fishery in 1952 and over 60 percent in 1953. Otter trawl logbook records were available for approximately 65 percent of the inshore fleet and 50 percent of the resident offshore fleet in 1952 and 1953. Surf clam logbook entries were available for 83 percent of the fleet in 1952 and 72 percent in 1953. Data for 1952 cover the period May through December only.

For the remainder of the commercial fisheries, amounts of gear fished, fishing grounds, and other detailed information not on the landing receipts were obtained from interviews with individual fishermen.

Surveys of the sport fishery were conducted by three separate agencies. The survey of the Ocean City, Maryland sport fishery was conducted by the authors. The Delaware survey was endorsed by the Fish and Wildlife Service with funds provided by the Dingell-Johnson Act and conducted by staff members of the Marine Laboratory, University of Delaware. The results herein presented have been extracted from published reports of that laboratory (Cronin, et al. 1952, 1954, and Daiber, 1954). The New Jersey sport fishing survey, similarly was sponsored by Dingell-Johnson funds and conducted by the Division of Fish and Game of that state. The results discussed herein are from that agency's files and published reports (Younger and Hamer, 1953, 1954a, and 1954b).

ACKNOWLEDGMENTS

Many persons have contributed to this report. The hundreds of fishermen who willingly kept daily accounts of their fishing activities, the dock owners who went to great lengths to make available their catch records, the cannery and processing plant operators who provided catch records and assisted in making the fishing logbook system a success -- to all these the authors gratefully extend their thanks.

The cooperation of the University of Delaware Marine Laboratory, in providing data respecting the sport and otter trawl fisheries of that state, is acknowledged. The New Jersey Division of Fish and Game furnished data on the sport fishery of that state. The Maryland Department of Research and Education provided detailed catch records of the commercial fisheries of Ocean City, Maryland.

Mr. Russel Soulen, Market News Specialist of the U. S. Fish and Wildlife Service, furnished certain detailed data which otherwise would have been unavailable to us.

MENHADEN PURSE SEINE FISHERY

Within the past decade, the fishery for menhaden in the western Atlantic Ocean and the Gulf of Mexico has become the leading fishing industry of the United States in terms of production. In 1953, the total yield amounted to

1.7 billion pounds with an estimated value of $30.6 million to the manufacturers. This was the largest catch by a single fishery ever recorded by Unites States fishermen. From this catch, 349.5 million pounds of dry scrap and meal and 17.8 million gallons of oil were obtained, valued at $21.8 million and $8.8 million respectively. In addition, the production of condensed fish solubles amounted to 78.1 million pounds with an estimated value of $3.6 million. For the same year the catch within the survey area amounted to over 620 million pounds with an estimated value of $7.1 million to the fishermen. These statistics serve to illustrate the importance of menhaden.

Although menhaden are exploited commercially in the coastal waters of the Atlantic Ocean from the Gulf of Maine to Cape Canaveral, Florida, and from Tampa Bay to the Rio Grande River in the Gulf of Mexico, between 35 and 51 percent of the total annual catches from 1939 to 1953 were taken from waters north of Cape Charles, Virginia. Of immediate concern in the present study is the fishery centered in the middle Atlantic area, extending from Barnegat Lightship southward to Winter Quarter Lightship.

Menhaden are caught by a specialized fleet of vessels by the use of purse seines, although pound nets, operated in the coastal waters for food fishes, contribute to the catches in certain areas. In the early days of the fishery, from its beginning in about 1851 to about 1865, gill nets and haul seines were used almost exclusively to capture menhaden in the shallow waters of bays and along the shores. With the development and expansion of the industry, those methods proved inadequate to secure sufficient quantities of fish, and the purse seine came into extensive use.

Vessels

Menhaden fishing vessels vary in size from about 54 to 152 feet in length and from about 30 to 358 gross tons in weight. They are powered by diesel engines ranging from 450 to 1,800 horsepower. Each is outfitted with a central hold for stowing fish. With the addition of side boards to the gunwales, the carrying capacity may be increased by stowing fish on deck. Most vessels are equipped with a two-way radio telephone and echo sounder. Radar is becoming standard equipment on many vessels. There were 33 vessels in the resident fishing fleet during the 1953 season.

The average menhaden vessel is operated by a crew of 29 men and carries two purse boats, a striker boat, and the purse seine. Purse boats may be constructed of wood or metal. They are about 30 feet long and powered by gasoline engines. On the fishing grounds, the purse boats are lashed together with the seine divided equally between them and towed behind the fishing vessel. The striker boat is a wooden, round bottom boat, about 12 feet long, with a beam of from 4 to 5 feet. It is operated by one man whose primary purpose is to maintain contact with a school of fish until the net is set.

Fishing Gear and Methods

A menhaden purse seine is essentially a large encircling net, made of cotton webbing, supported by cork floats at the surface and weighted by leads at the bottom. A purse line, which runs through brass rings attached by rope bridles at intervals to the lead line, provides the means for closing the net. The net is closed, after it is set in a circle around a school of fish, by means of a heavy block of lead, called the "tom" weight, which rides down the purse line and holds the ends and bottom of the net together while it is being pursed. Purse seines vary slightly in different localities but, generally, are about 200 fathoms long and from 10 to 15 fathoms deep, with a cotton web of 1-3/4-inch mesh.

Menhaden fishing is carried on exclusively during daylight hours. Usually the vessels make daily runs to the fishing grounds from processing plants located at strategic places along the coast. Fishing generally commences about dawn and continues until dark or until the hold has been filled.

Fish are located from the crow's nest of the seine vessel by watching for the distinguishing reddish "color" or flipping of the fish on the surface of the water. In recent years spotting planes also have been used routinely for locating fish. Once a school is located, the striker boat is cast off to maintain contact with the fish while purse boats approach the school. When they are

prepared to encircle the fish, the two purse boats are separated and headed in opposite directions, both boats paying out the seine until the circle is completed. At that point, pursing commences using the tom weight. The tom is heaved overboard and rides down the purse line closing off the bottom of the net while the men in each boat haul the ends of the net aboard. The wings of the net are gradually "webbed in" and the fish confined to the center of the net, called the bunt. When the net is sufficiently "dried up", the vessel comes alongside the purse boats, and the catch is bailed into the hold of the fishing vessel by means of either a huge dip net or a suction hose. An average set of the net yields about 20 tons of fish, although sets yielding nearly 170 tons have been made. Detailed descriptions of fishing vessels, gear, methods, and the development of the fishery may be found in Lee (1952 and 1953); Harrison (1931); Greer (1917); Miles and Simmons (1950); and others.

Fishing Grounds

For the purposes of this study, the area chosen for consideration includes the coastal waters of New Jersey, Delaware, and Maryland, between Barnegat Lightship and Winter Quarter Lightship. The data presented here are precise plotting of location and relative importance of the grounds fished by the purse seine fleet operating from menhaden-processing plants located within these arbitrary boundaries. Occasionally, vessels operating from plants located outside the area fish on the same grounds, and similarly, local vessels extend their operations into waters outside the general area. The amount of interchange between the fleets varies from year to year, depending upon the availability of fish. Fishing effort expended by the resident purse seine fleet outside the survey area amounted to approximately 8 percent in 1952, while in 1953 it was 21 percent.

In summarizing the data for each season, the amount of fishing effort (number of sets) expended by the purse seine vessels within a given subarea, defined as a unit area bounded by 10 minutes of latitude and 10 minutes of longitude, was determined and expressed in percentage of the total number of sets made. Figures 2 and 3 show the areas of heavy (greater than 4.0 percent), moderate (2.0 to 3.9 percent), and light (0.1 to 1.9 percent) fishing.

It is apparent that the grounds of greatest importance to the middle Atlantic menhaden purse seine fishery lie roughly within the 10 fathom contour, between Barnegat Inlet, New Jersey, and Ocean City, Maryland. Of the total fishing effort represented, 90.6 percent was spent on these grounds in 1952 and 72.6 percent in 1953.

Although the distribution of effort shows remarkable similarity for the two seasons, there was somewhat less fishing inside Delaware Bay in 1953 (1.6 percent) than in 1952 (10.6 percent). Fishing extended farther offshore in 1953 (up to 35 miles), especially in the waters north of Delaware Bay. Areas south of Ocean City, Maryland, are of little importance to the middle Atlantic purse seine fleet.

Catch

Apart from annual fluctuations in total catch, the general trend is upwards over the 15-year period, 1939-1953, within the area considered (fig. 4). This may be explained, partly at least, by the expansion and development of the fish meal industry following the outbreak of World War II. The increased demand for high-protein meal for animal rations, together with favorable marketing conditions, have stimulated expansion of the fishery. Doubtless the decline of the sardine and herring fisheries of the Pacific coast during this period also had favorable effects on the menhaden industry. Between 1939 and 1953, the total catch exceeded 120,000 tons in 9 years, 150,000 tons in 3 years, and 300,000 tones in 1 year. The largest catch was recorded in 1953 when 311,000 tons of fish were landed.

Compilation and Analysis of Data

In calculating a measure of abundance, comparisons were made of the catch of a group of vessels in one year with the catch of the same group in the adjacent years. This method of "linkage" is similar to one often used by economists in expressing changes in commodity prices, and descriptions may be found in Croxton and Cowden (1953). Summary data on vessels and catch are given in table 1.

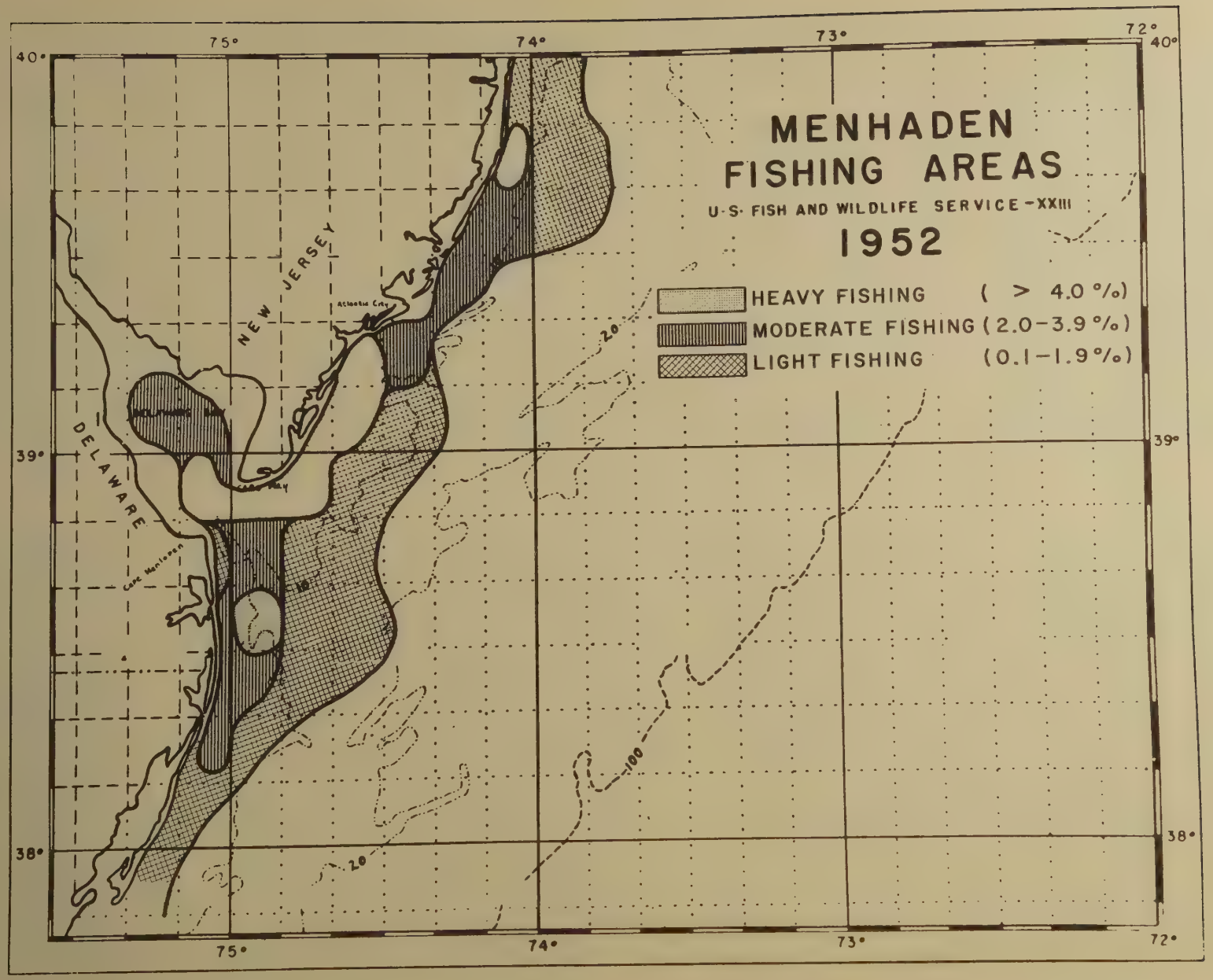

Figure 2.--Menhaden fishing areas, 1952

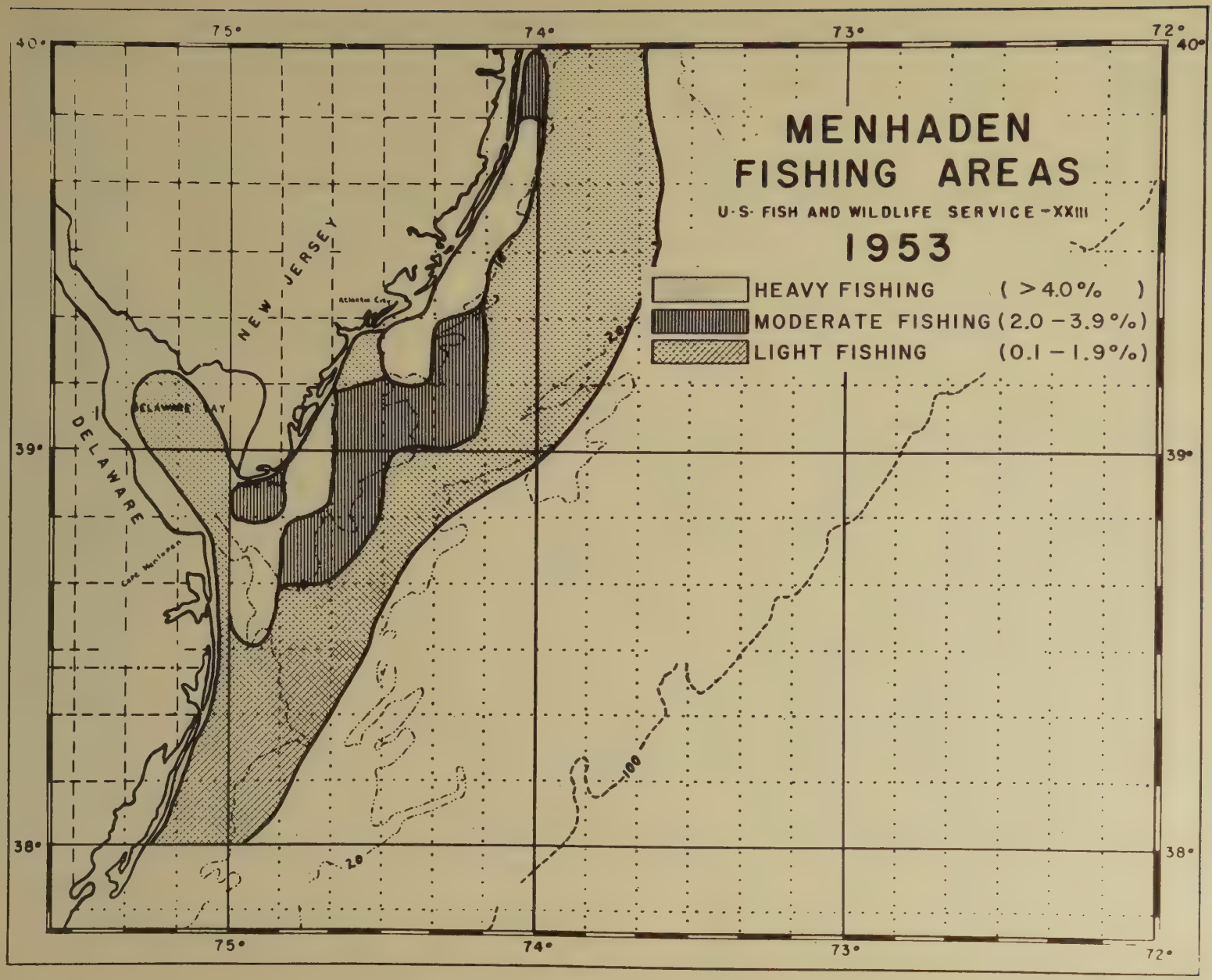

Figure 3.--Menhaden fishing areas, 1953

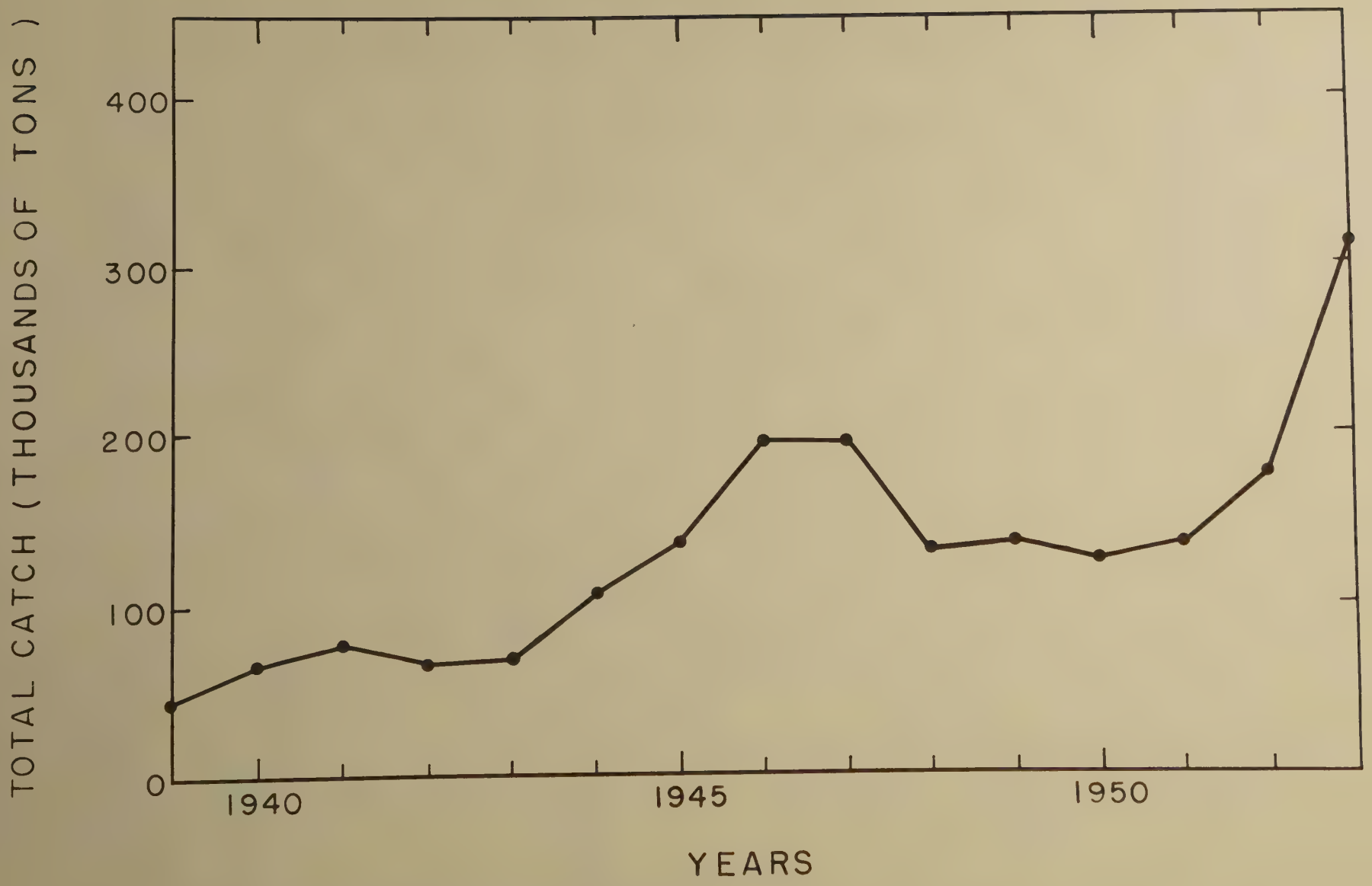

Figure 4.--Menhaden purse seine fishery, 1939-1953

Table 1.--Summary data, menhaden purse seine fishery, 1939-1953

Year	Total number of vessels fishing*	Mean registered length	Mean gross tonnage	Number of vessels in select fleet	Percent of total used in analysis	Total catch in thousands of tons	Catch by vessels in select fleet in thousands of tons	Percent of total catch landed by select fleet	Total tons landed outside season 6/1-10/4	Percent landed outside season
1939	15	119.0	204.7	14	93.3	47	40	85.1	4,334	9.3
1940	19	123.1	203.3	15	78.9	66	50	75.8	211	0.3
1941	19	114.5	183.9	13	68.4	79	53	67.1	5,650	7.2
1942	18	117.8	165.8	12	66.7	67	39	58.2	659	1.0
1943	15	114.0	152.6	13	86.7	70	59	84.3	164	0.2
1944	24	112.9	154.7	16	66.7	106	70	66.0	2,754	2.6
1945	24	115.8	172.5	23	95.8	137	127	92.7	6,735	4.9
1946	25	117.1	170.8	25	100.0	198	192	97.0	1,741	0.9
1947	28	114.1	166.5	26	92.8	198	186	93.9	4,964	2.5
1948	34	117.4	177.7	32	94.1	131	114	87.0	8,815	6.7
1949	35	119.7	185.8	34	97.1	138	128	92.7	7,959	5.8
1950	33	119.3	178.8	30	90.9	128	122	95.3	329	0.2
1951	32	119.0	176.9	30	93.8	136	130	95.6	425	0.3
1952	26	123.7	193.2	26	100.0	175	157	89.7	3,662	2.1
1953	33	123.5	194.8	25	75.8	311	232	74.6	26,784	8.6

* Includes only those vessels that fished exclusively for menhaden; in certain years, foodfish seiners entered the fishery for varying periods.

Fishing normally begins in this area of the coast during the first week in June and terminates during the first week in October. Irregularities in the movements and behavior of the fish, weather, and other factors, may extend either end of the season (fig. 5). To eliminate those scattered landings which preceded and followed the period when the bulk of the catch was made each year, the period June 1 through October 4 arbitrarily was chosen for the analysis. For the period of this study, the landings outside the season, thus defined, amounted to no more than 9.3 percent of the total catch in any year (table 1). The season June 1 - October 4 was divided into 7-day periods (boat-weeks) and comparisons made of each 7-day period with the corresponding period in the following season. There were 18 such time units in the season.

It will be recognized that great variability exists in the size and efficiency of a group of vessels over a period of time. It was desirable therefore, to employ a catch-per-unit index which tended to minimize these factors as much as possible. One such measure would involve the selection of those vessels which had fished continuously over the 15-year period. Because vessels were leaving and entering the fishery throughout the period, however, it was impossible to obtain a sufficient number to yield a reliable measure.

To establish criteria for the selection of boats, several conditions had to be considered. In certain years some vessels did not fish the entire season due to breakdowns or other reasons independent of the availability of fish. To minimize possible bias, vessels which landed fish in less than one-half the number of boat-weeks in a season were omitted. Furthermore, there is no sure way of ascertaining whether a boat was fishing during periods when it made no landings. It was found, however, that the bulk of zero catches occurred at the beginning or end of a given season, suggesting the vessels were not fishing during the period in question. Finally, the number of zero catches during any given season being small, no adjustment was made for these values. This resulted in the eliminating of no more than 4.0 percent of the data for any pair of seasons over the period considered.

Applying the time unit (boat-week) and the criteria for selecting vessels in the fleet, it is possible to make a series of comparisons for each of the pairs of seasons for the period 1939-1953.

The total tonnages delivered by all boats in the selected fleet each season were summed. The sum for the second of a given pair of years was divided by the sum of the first year yielding the ratio of the second year to the first. The total tonnage was then divided by the total boat-weeks to obtain the catch per boat-week for each season.

A series of indices of catch per boat-week was obtained using 1946 as the base year. By means of the ratios, other years were linked to 1946 and the index values determined. The calculated values are given in table 2 and shown graphically in figure 6.

Table 2.--Catch per unit effort and fishing effort, menhaden purse seine fishery, 1939-1953.

Year	Tons per boat-week	Calculated fishing effort
1939	215	217
1940	244	271
1941	272	290
1942	213	313
1943	323	216
1944	324	328
1945	336	407
1946	447	443
1947	460	431
1948	237	555
1949	224	616
1950	211	606
1951	212	644
1952	307	571
1953	434	717

The calculated catch per unit effort (fig. 6) shows a general upward trend from 1939 to 1947, then decreased until 1951. This was followed by a rather marked upward trend in 1952 and 1953. The calculated catch per boat-week in 1946 and 1947 (447 and 460 tons respectively) was more than double that of 1939

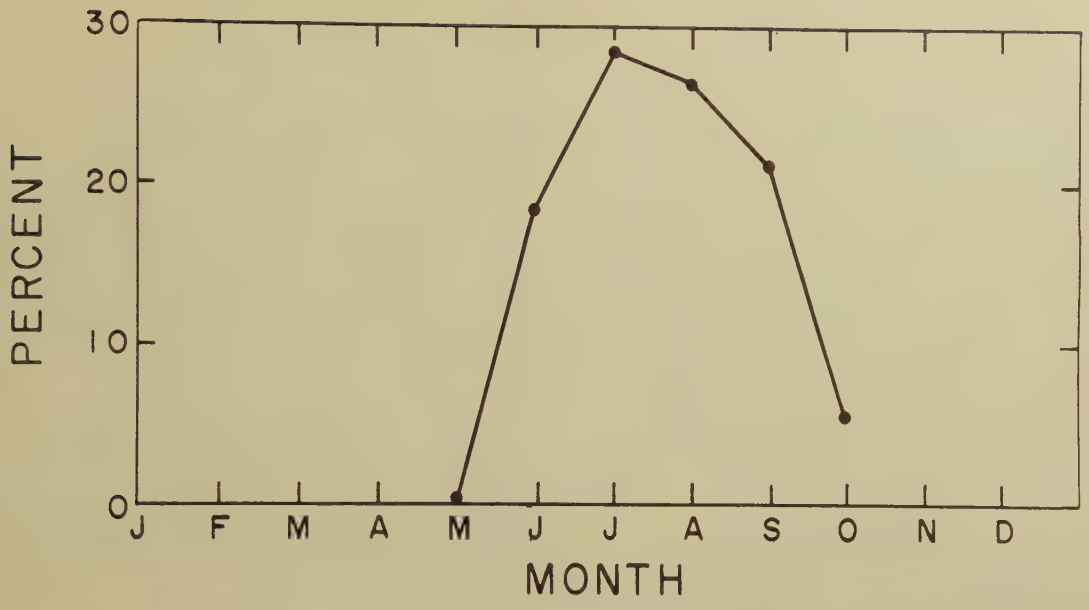

Figure 5.--Menhaden landings, in monthly percentages, 1939-1953

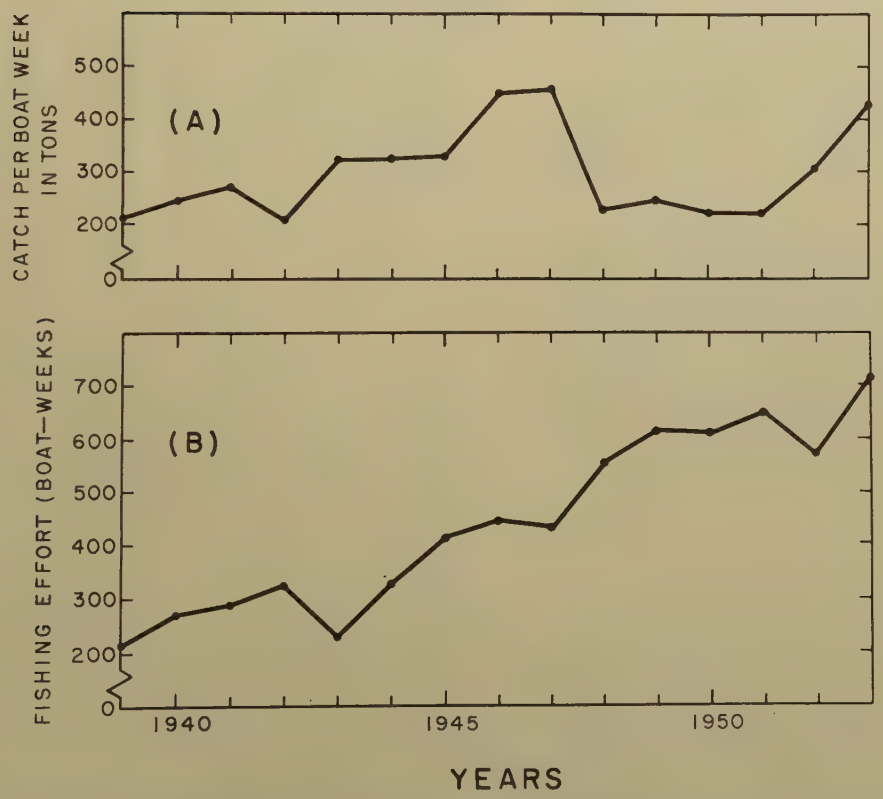

Figure 6.--Menhaden purse seine fishery; catch per unit effort, and fishing effort, 1939-1953

(215 tons). From 1948 to 1952 it averaged approximately 238 tons, while in 1953 (434 tons) it was nearly twice that of 1948 (237 tons).

Total fishing effort, expressed in terms of boat-weeks, may be estimated once the catch per unit effort index has been determined, by dividing the total catch by the average catch per boat-week. It may be seen from table 2 and figure 6 that fishing effort increased over the period, reaching a peak in 1953.

Discussion

The method employed in computing the catch per unit index does not completely eliminate effects resulting from factors other than changes in availability of fish to the fishermen. Doubtless there has been some variation in the experience and efficiency of vessel crews, due chiefly to the addition of new fishermen over the period of expansion. The use of echo sounders, radar, scouting planes, radio telephones, and increased capacities of plants also effect the apparent availability. Furthermore, the amount of time that an individual vessel spends in actual fishing may vary from year to year. Although such factors as weather, vessel and plant breakdowns, net repairs, etc., should average out over a period of years, more important is the reduction in actual fishing time during seasons when menhaden are relatively more abundant. The latter would tend to influence the calculated availability index to a greater extent during years of relatively high abundance than during years of relatively low abundance.

A point of further concern, possibly, involves the use of arithmetical means, rather than geometrical means, in computing the index of abundance, since the latter is the best measure for averaging rates of change. Frequency distributions of relatives are often skewed: if the logarithms of the variate are computed, the resulting frequency distributions usually prove to be of the symmetric type. Various fishery workers (Clark, 1939; Rounsefell, 1931) also have observed that frequency distributions of catches often exhibit a fairly high degree of positive skewness. In the present study it was found that when vessel catches were plotted for each year, the resulting curves approximated normality. No system of weighting was applied.

Mention should also be made of the reduction in the number of fishing days for those weeks in which the fishermen are paid. Although each boat-week in the defined season contains six possible fishing days (excluding Sundays), fishing does not take place on the Saturday ending each two week pay period. Thus, some boat-weeks contain only 5 fishing days. Short weeks, however, are more or less random occurrences from season to season, and their effect on the calculated catch per unit index should average out about the same over the period of years considered.

In summary, the sources of error pointed out above doubtless affect the accuracy of the calculated index and must be considered in interpreting changes and trends in abundance. The calculated indices provide a rough measure of broad changes occurring in the fishery, and with certain limitations may be considered to be proportional to the abundance of fish on the grounds during the fishing season.

OTTER TRAWL FISHERY

The otter trawl was introduced into the waters of the western Atlantic in 1905. Although its use quickly spread in the New England fisheries, it was not generally adopted in the middle Atlantic region until after the close of World War I. In 1921, only 9 otter trawlers operated out of New Jersey ports; by 1950 their number had increased to 92 . In 1939, a resident trawl fleet was established in Ocean City, Maryland. Itinerant trawlers, however, had landed catches at this port following the opening of the inlet in 1935. Only one trawler operated in Delaware . prior to 1946. At present, resident vessels operate from ports located in southern New Jersey, Delaware, and Maryland. In addition, a fleet of offshore trawlers from southern New England and Virginia, numbering as many as 40 vessels in certain years, fishes in these waters. Except for occasional landings, however, their catches are landed at home ports. In 1953, otter trawl landings within the survey area exceeded 20 million pounds of food fish with an estimated value of about $2.0 million to the fishermen.

The otter trawl fishery comprises two distinct resident fleets: (1) an inshore fleet of small and medium-sized vessels which make daily trips to fishing grounds located within the 15 fathom curve, and (2) an offshore fleet of larger vessels which, in general, fishes from 2 to 6 days each trip in the deeper waters outside the 15 fathom curve.

Vessels

Vessels used for otter trawling range from less than 30 feet to over 100 feet in length. Small and medium-sized vessels (commonly called draggers), up to about 50 feet, are used mostly for inshore trawling, whereas larger vessels are principally offshore trawlers. Most are powered with diesel engines, with a power take-off to operate the winches. Some of the older and smaller boats employ gasoline engines, but replacement engines usually are of the diesel type. Basic equipment on these vessels include a two-way radio telephone, a recording echo sounder, and a power driven winch and cable for towing the trawl. A central hold provides storage space for the catch.

Inshore vessels normally are operated by two or three men, while the offshore vessels usually carry from 6 to 8 men.

Fishing Gear and Methods

The otter trawl is a large flattened, conical net, approximately 100 feet long, designed for towing along the ocean floor. The mouth, about 75 feet wide, is held open laterally by the kite-like action of two otter boards. The upper section, or headrope of the net, overhangs the opening and is buoyed by floats. The fish collect in a terminal bag of heavy twine called the cod end. The net is towed by two cables, one attached to each otter board.

In operation the net is set on the windward side. The vessel circles to the windward until the net, ground ropes, otter boards, and towing cables are paid out. The net is towed from 2 to 4 miles per hour from one-half to 3 hours, depending on the grounds and species fished. At the end of the tow, the vessel is stopped, the net recovered, and the catch dumped on deck for sorting and stowage. Detailed descriptions of the otter trawl and methods of fishing may be found in Pearson (1932).

The inshore fleet uses two different nets - a "flatfish" net for fluke and a "roundfish" net for porgy, weakfish, and similar fishes. The former is constructed of larger mesh and is towed at relatively slow speed. The "roundfish" net is characterized by smaller mesh webbing and longer wings. Some small and medium-sized vessels carry and often fish both nets during a day's fishing.

In the offshore fleet, a larger trawl is used. It is constructed of heavier materials and rigged with sturdier cables, shackles, and otter boards. Tows last from one to three hours in depths up to 100 fathoms or more.

Fishing Grounds

The grounds of interest to the otter trawl fishery lie between Barnegat Lightship and Winter Quarter Lightship, seaward to the 100 fathom curve.

The inshore trawl fleet usually operates inside the 15 fathom contour, which lies from 20 to 30 miles offshore. The grounds fished during 1952 and 1953 are shown in figures 7 and 8, respectively. In both years, over 50 percent of the fishing effort was spent within an area of less than 300 square miles, located just east and southeast of the mouth of Delaware Bay. These highly productive grounds lie immediately off the bay entrance in depths of 6 to 12 fathoms. Five Fathom Bank and surrounding waters, the areas just northeast and east of Atlantic City, New Jersey, and east of Ocean City, Maryland, also are important. The area immediately off Indian River and Fenwick Island, Delaware, is not fished as intensively as grounds just north and south of it. This is probably due to the firing range which restricts this area to military use during much of the year.

Best fishing grounds for fluke are the sloughs or inshore deeps during the summer months and the offshore shoals during the fall and early winter. Weakfish, porgy, and other roundfish usually are taken in the vicinity of off-

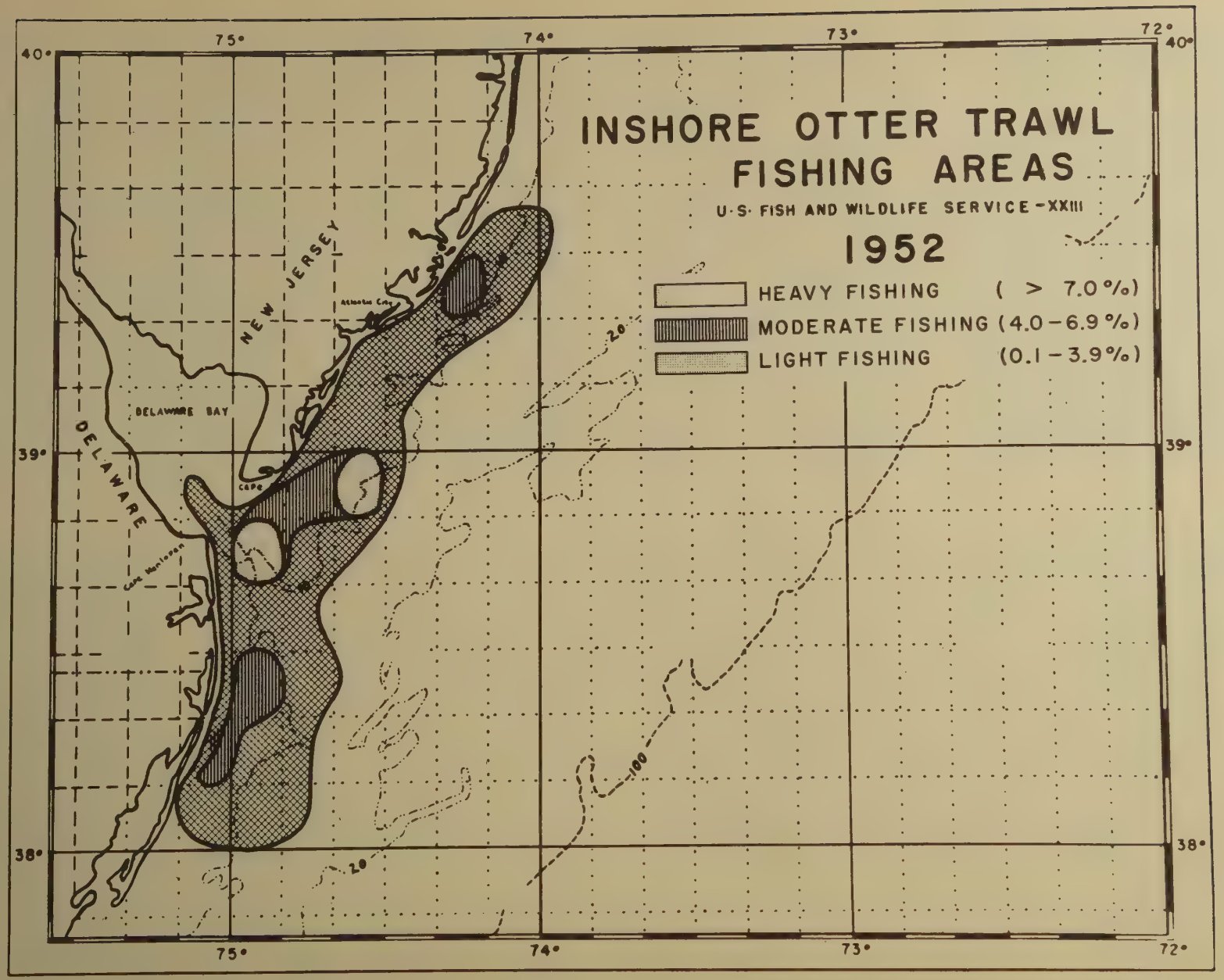

Figure 7.--Inshore otter trawl fishing areas, 1952

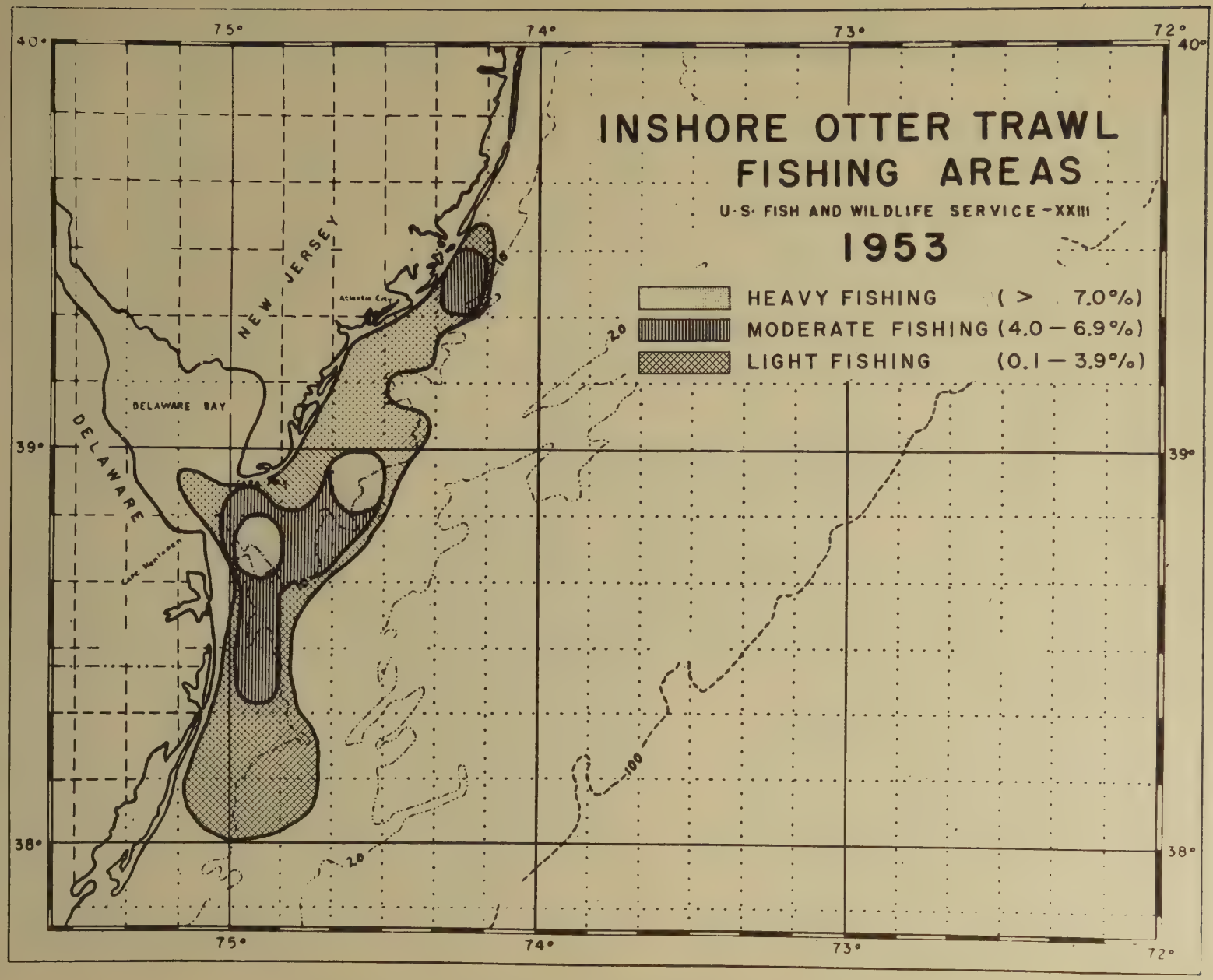

Figure 8.--Inshore otter trawl fishing areas, 1953

shore banks or shoals or along channels during the spring and fall migrations. Nets for roundfish and flatfish are readily interchangeable, and often the same vessel will fish both nets, in the shallow waters along the coast, during a single day's operations.

The offshore trawl fleet fishes over a wide range of depths and localities. Fishing normally begins somewhere between the 10 and 15 fathom lines in early October and gradually moves farther offshore until much of the trawling in February and March is done along the edge of the continental shelf. The grounds fished during the 1952-1953 season are shown in figure 9. Fishing occurs throughout the entire area. Grounds of greatest importance to the fishery lie 30 to 60 miles southeast of Delaware Bay, roughly defined by a circular area of approximately 1,500 square miles. Over 50 percent of the fishing effort was spent on these grounds in 1952-1953.

Catch

During the 8-year period, 1946 through 1953, the average annual production of the otter trawl fishery within the survey area was 176 million pounds (fig. 10). Following an initial peak in 1947, the catch declined steadily through 1951. A catch of over 20 million pounds was recorded in 1953. The trend of offshore trawl production has been upward, while the inshore trawl yield has declined somewhat over the 8-year period.

Inspection of tables 3 and 4, which list species composition for the inshore and offshore fleets respectively, shows that fluke, porgy, and weakfish accounted for nearly 75 percent of the inshore landings, and porgy, sea bass, and fluke comprised 86 percent of the offshore catch during the period considered. From table 3 it may be seen that whiting was the most important species in 1946 and 1947. It contributed little to the catch in subsequent years. Fluke has become of increasing importance and comprised over one-half the total catch in 1953. In the offshore trawl fishery, percentage contribution of the three principal species has fluctuated within rather narrow limits, with the possible exception of sea bass (table 4). Porgy has, almost consistently, led other species. Composition of the "all others" category varies somewhat from season to season. However, changes between seasons usually are less than one percent of the annual landings. Table 5 lists the miscellaneous species contributing to the inshore and offshore catches.

The inshore otter trawl fleet operates during the entire year, although fishing during the winter months is somewhat sporadic due to unfavorable weather conditions. The fish, generally, are less abundant on the inshore grounds during this period. The first appearance of the fish, marking the commencement of the summer fishery, usually occurs in May. Figure 11 shows the season of peak production with average monthly catches expressed as percentages of the average annual catch for the 8-year period, 1946 through 1953. About 86 percent of the landings are made in the period May through November. It should be noted that the fishery for whiting and red hake in 1946 and 1947 was pursued most intensively in April and May.

The offshore trawl fleet also fishes throughout the year. Over 90 percent of the landings, however, are made from October through May. Figure 12 shows the average monthly percentage of the annual catches for the period 1946 through 1953.

Compilation and Analysis of Data

Methods of calculating apparent abundance of food fishes in the trawl fishery were essentially the same as for the menhaden fishery. Because of differences in season of operation, fishing grounds, vessel efficiency, and, to a certain extent, species composition, between the inshore and offshore fleets, a separate series of indices was calculated for each.

To eliminate those scattered landings which preceded and followed the period during which the bulk of the catches were made, the following seasonal periods were chosen for the analyses:

1. Inshore fleet - May through October
2. Offshore fleet - October through June.

Criteria for selection of vessels used in the analyses were generally the same for both

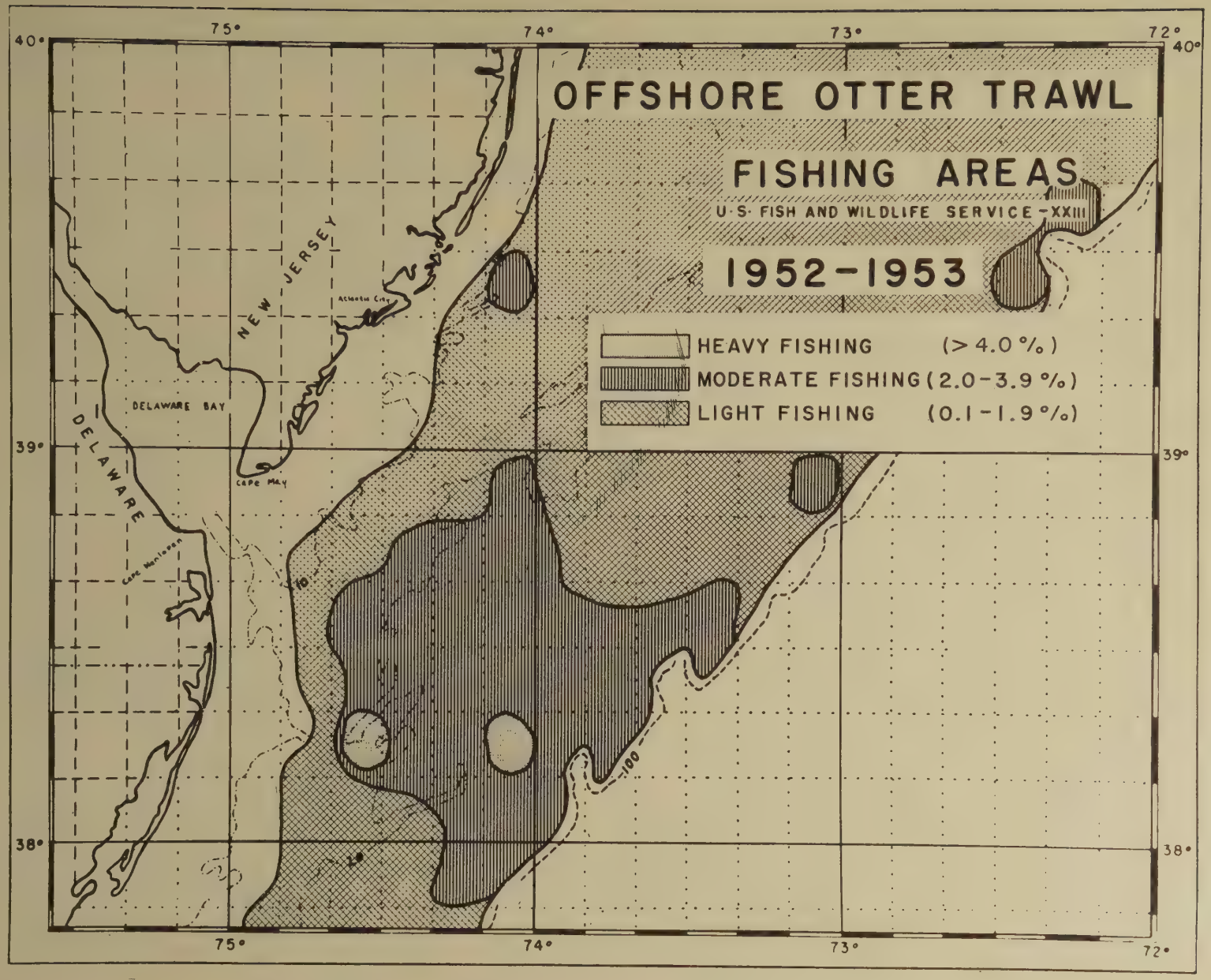

Figure 9.--Offshore otter trawl fishing areas, 1952-1953

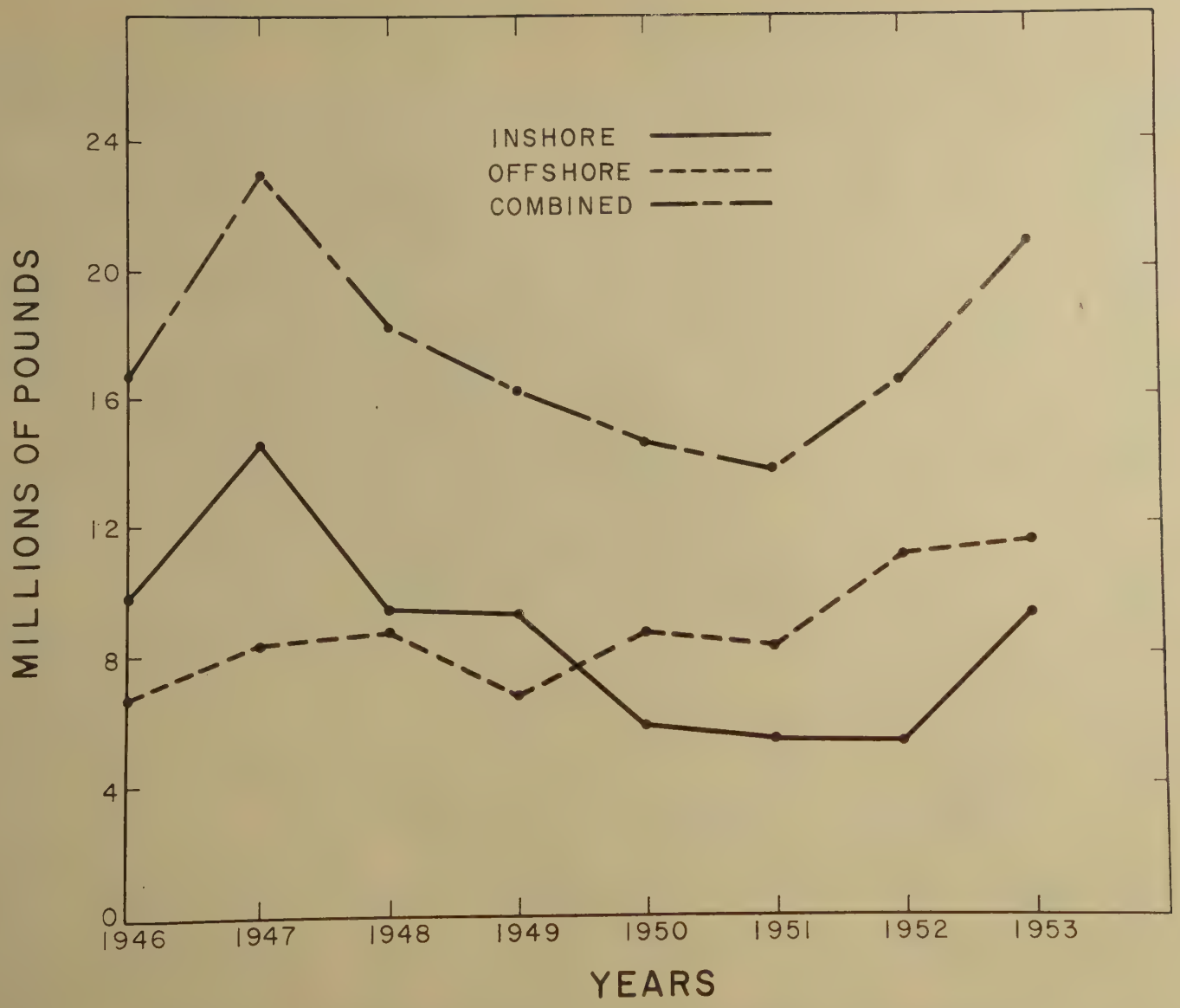

Figure 10.--Otter trawl landings (inshore, offshore, and combined) 1946-1953

Table 3.--Species composition, inshore otter trawl landings, in thousands of pounds, 1946-1953.

Year	Fluke	Porgy	Weakfish	Whiting	Croaker	Sea bass	Red hake	Butter-fish	All Others	Total
1946	1,665	694	2,219	3,626	277	30	347	377	673	9,908
1947	2,163	1,292	2,003	4,559	580	261	2,206	160	1,294	14,518
1948	2,333	2,685	2,342	114	362	419	143	114	1,009	9,521
1949	2,067	3,334	2,328	<1	261	410	3	373	537	9,313
1950	1,699	2,234	968	<1	255	297	<1	119	368	5,940
1951	1,349	1,730	1,465	4	243	348	3	171	214	5,527
1952	2,350	1,147	1,280	33	193	154	3	39	317	5,516
1953	4,197	1,081	1,960	317	345	67	17	168	226	8,378
Mean Percent	28.2	22.9	22.0	9.2	3.4	3.2	2.6	2.2	6.3	

Table 4.--Species composition, offshore otter trawl landings, in thousands of pounds, 1946-1953.

Year	Porgy	Sea bass	Fluke	Butter-fish	Squid	All others	Total
1946	2,764	330	2,118	413	83	1,168	6,876
1947	3,405	2,011	1,326	482	211	1,013	8,448
1948	3,627	2,318	1,607	228	307	695	8,782
1949	3,156	1,733	1,236	97	359	325	6,906
1950	4,825	1,948	1,062	175	307	456	8,773
1951	3,242	3,317	1,145	150	276	226	8,356
1952	4,692	3,455	1,678	596	254	364	11,039
1953	6,036	1,853	2,331	606	210	617	11,653
Mean Percent	44.4	23.6	18.0	3.8	2.9	7.2	

Table 5.--Minor species, otter trawl fishery, in percent, 1946-1953

Inshore		Offshore	
Species	Percent	Species	Percent
Squid	0.9	Whiting	0.9
Conch	0.9	Weakfish	0.7
Sea herring	0.7	Lobster	0.7
Cod	0.7	White hake	0.7
King whiting	0.6	Tilefish	0.5
Striped bass	0.5	Croaker	0.4
Spot	0.3	Conger eel	0.3
White perch	0.3	Bluefish	0.2
Bluefish	0.1	Red hake	0.2
Windowpane	0.1	Cod	0.1
Mackerel	0.1	Miscellaneous	0.5
Miscellaneous	1.2		

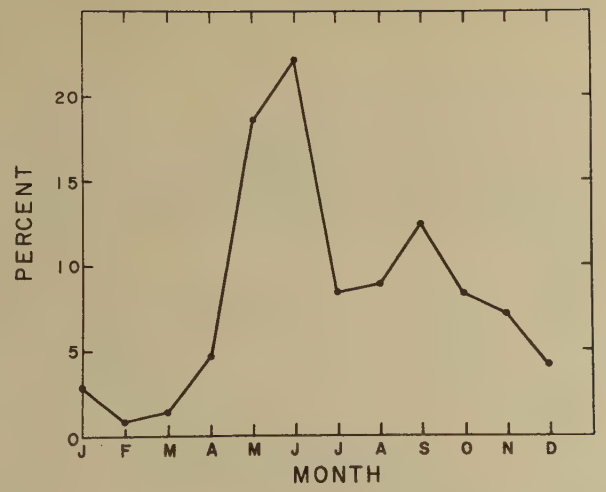

Figure 11.--Inshore otter trawl landings, in monthly percentages, 1946-1953

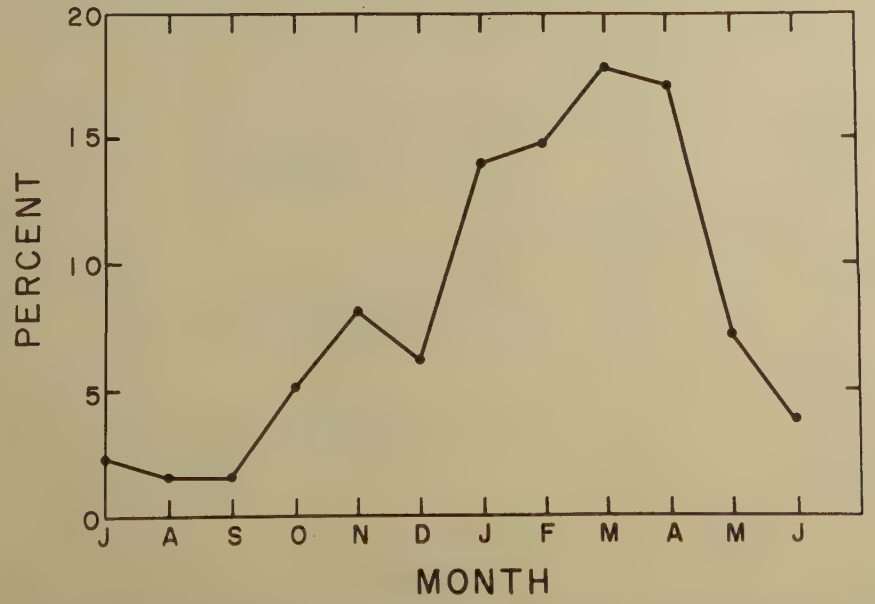

Figure 12.--Offshore otter trawl landings, in monthly percentages, 1946-1953

fleets. To be included in the selected fleet, (1) a vessel had to fish at least one less than half the number of months in the season, defined above; and, (2) the months during which landings were made had to be the same between adjacent years. It should be noted that few changes occurred in the trawl fleet over the period considered.

Applying the above criteria, a series of indices was calculated for each fleet for the period 1946 through 1953, using 1949 as the base year. Pertinent summary data for the analyses are given in tables 6 and 7.

In figure 13 are plotted measurements of total catch, the catch per boat-month, and fishing effort for the inshore trawl fleet for the 8-year period within the area. Whiting was principally responsible for the relatively high level of abundance in 1947, and the decline in 1948 was associated with a decreased abundance of this species on the grounds. Subsequently, the curve reached its lowest level in 1950. The rather sharp increase in 1953 resulted from an increased catch per boat-month of fluke. However, calculated fishing effort shows a generally downward trend after 1947.

Statistics pertaining to the offshore trawl fleet are presented in figure 14. It may be seen that production has risen appreciably during the latter half of the period considered. Catch per boat-month indicates a slight upward trend, fluctuating about 65,000 pounds over the 7 seasons, and calculated fishing effort in 1952-53 reached its highest level since the 1946-47 season. The value for the 1946-47 season, however, may be regarded with some suspicion as only about 50 percent of the records were available.

Interpretation of these results must be made with certain reservations, since both fisheries are affected by various factors independent of fish abundance as indicated by catch per unit effort. The inshore trawl fleet, in effect, pursues two separate and distinct fisheries, each employing different nets, fishing methods, and grounds - one for fluke and the other for roundfish. Trawlers frequently will fish both fluke and roundfish in different areas on the same day. It is impossible to assign the catch to one fishery or the other. In general, the average daily catch of roundfish is about twice that of fluke. During periods of heavy roundfish production, landings often are controlled by catch limits imposed by the docks handling the fish. Such restrictions rarely apply to fluke.

These factors undoubtedly influence the total catch and the calculated indices of abundance, yet, for purposes of analysis, there is no way of separating the two fisheries or applying methods of adjustment which might yield unequivocal results.

Economic conditions also may cause apparent fluctuations in yield and measures of abundance derived therefrom. Oftentimes market demand and accompanying prices dictate the activities of the trawl fleets for varying periods throughout the year. Consequently, certain desirable species will be sought to the exclusion of those of lesser market demand. In figure 15, for example, are shown landings of porgy, weakfish, and fluke, which three species comprised over 83 percent of the inshore trawl catch for the period 1946 through 1953. Although total production may have little relation to the abundance of these species, the rise and fall of porgy landings are contrasted with a more stable weakfish catch and an increase in fluke yield. The increase in fluke landings in 1952 and 1953 suggests a real increase in the availability of the fish on the inshore grounds. Market demand and prices paid for fluke in 1952 and 1953 reached the highest levels in the 8-year period, thus the decline in porgy landings could have resulted from a decrease in fishing effort for this species occasioned by increased fishing effort, greater demand, and higher prices paid for fluke. In contrast, figure 16 shows landings of porgy, sea bass, and fluke by the offshore trawl fleet for the same period, accounting for over 92 percent of the catch for the 7 seasons. While porgy landings in the inshore fleet showed a continued decline in 1952 and 1953, the yield of this species sharply increased in 1952-53 in the offshore fishery.

In summary, the above factors undoubtedly affect the reliability of calculated indices for the trawl fisheries, and, at best, the measures probably reflect only gross changes in the abundance of individual species on the fishing grounds.

Table 6.--Summary data, inshore otter trawl fishery, 1946-1953

Year	Estimated total number of vessels	Number of vessels in select fleet	Percent of total used in analysis	Estimated total catch in pounds	Catch in pounds of select fleet	Percent of total landed by select fleet	Total pounds landed outside season	Percent landed outside season
1946	88	30	34.1	9,908,000	1,950,500	19.7	2,992,000	30.2
1947	87	50	57.5	14,518,000	4,763,000	32.8	4,239,000	29.2
1948	86	61	70.9	9,521,000	5,082,000	53.4	1,514,000	15.9
1949	85	58	68.2	9,313,000	5,754,000	61.8	745,000	8.0
1950	73	59	80.8	5,940,000	4,643,000	78.2	338,600	5.7
1951	61	46	75.4	5,527,000	4,242,000	76.8	326,000	5.9
1952	62	46	74.2	5,516,000	4,082,000	74.0	353,000	6.4
1953	66	45	68.2	8,378,000	5,846,000	69.8	942,000	11.2

Table 7.--Summary data, offshore otter trawl fishery, 1946-1953

Season	Estimated total number of vessels	Number of vessels in select fleet	Percent of total used in analysis	Estimated total catch in pounds	Catch in pounds of select fleet	Percent of total landed by select fleet	Total pounds landed outside season	Percent landed outside season
1946-47	45	6	13.3	7,961,000	1,074,000	13.5	589,000	7.4
1947-48	46	10	21.7	8,954,000	3,300,000	36.9	522,000	5.8
1948-49	46	12	26.1	8,447,000	3,776,000	44.7	162,000	1.9
1949-50	53	13	24.5	7,695,000	4,464,000	58.0	1,377,000	11.9
1950-51	57	13	22.8	9,077,000	5,702,000	62.8	383,000	4.2
1951-52	64	17	26.6	9,790,000	8,372,000	85.5	425,000	4.3
1952-53	64	17	26.6	10,115,000	6,643,000	65.7	707,000	7.0

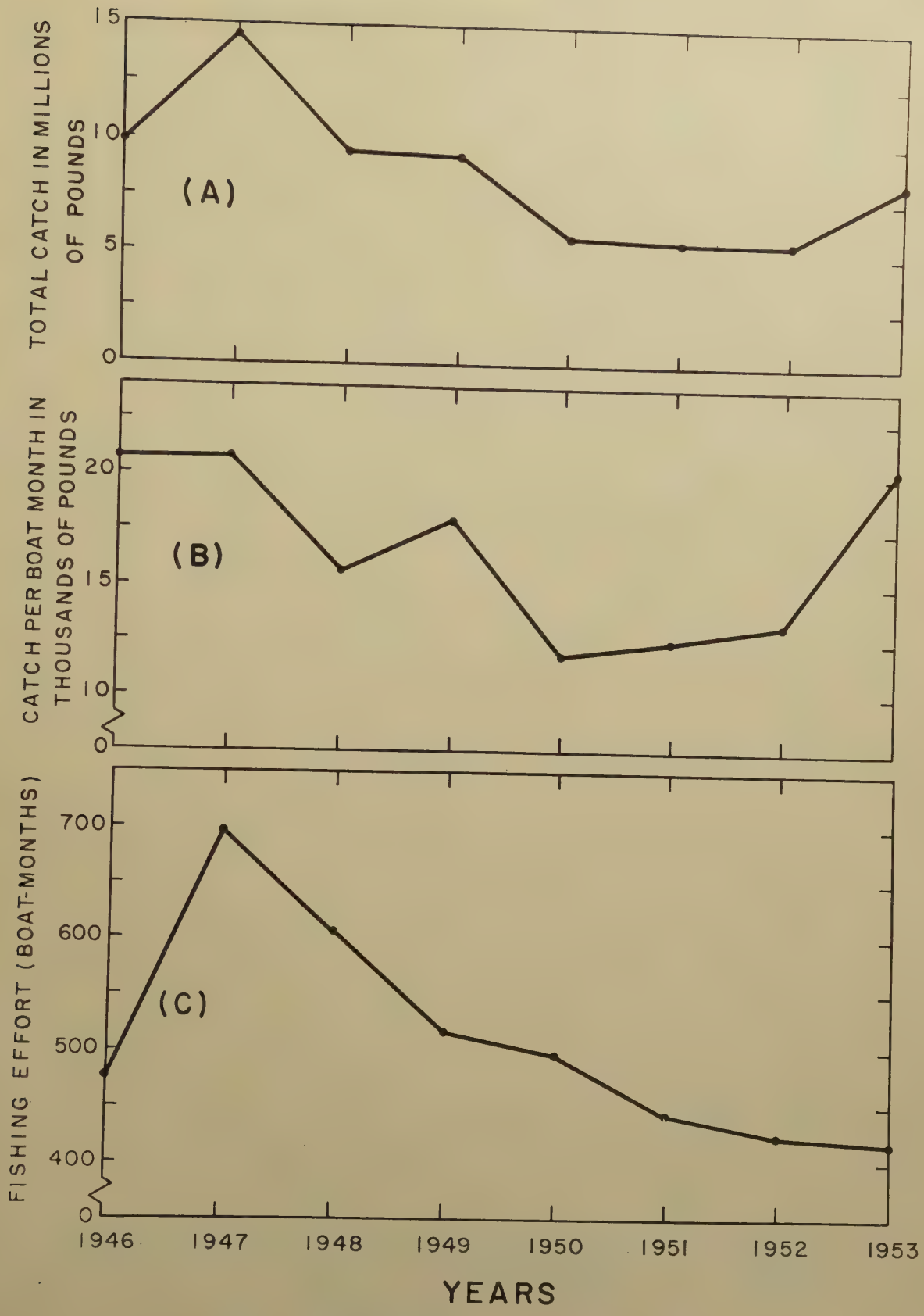

Figure 13.--Inshore otter trawl fishery; total catch, catch per boat-month and fishing effort, 1946-1953

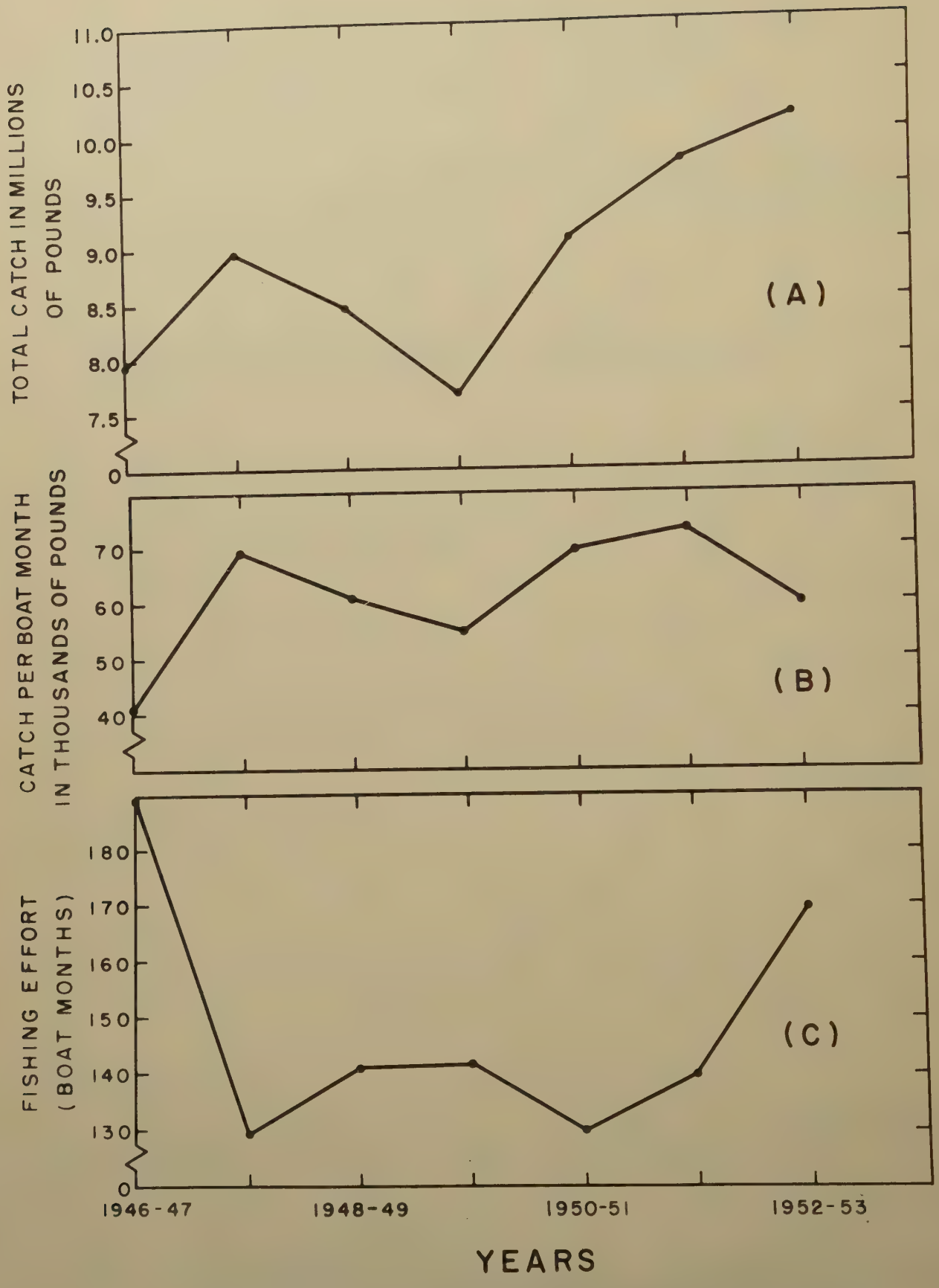

Figure 14.--Offshore otter trawl fishery; total catch, catch per boat-month, and fishing effort, 1946-1953

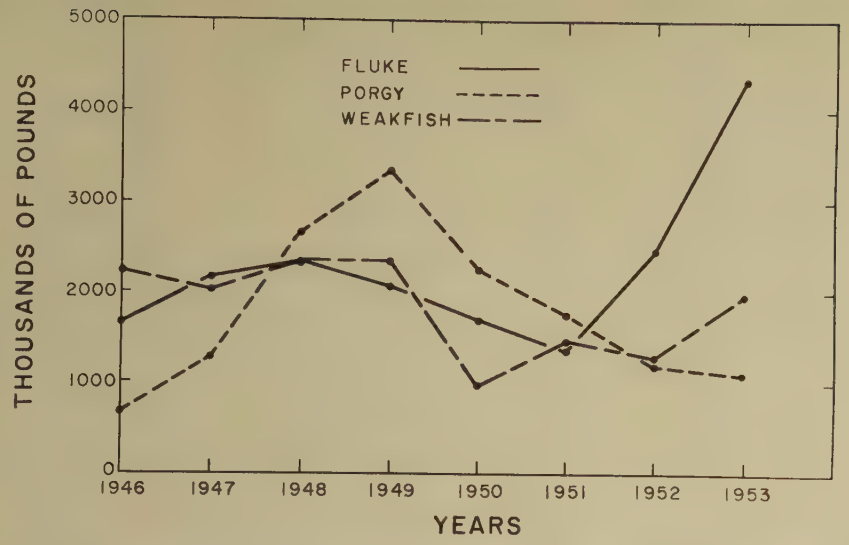

Figure 15.--Principal species, inshore otter trawl fishery, 1946-1953

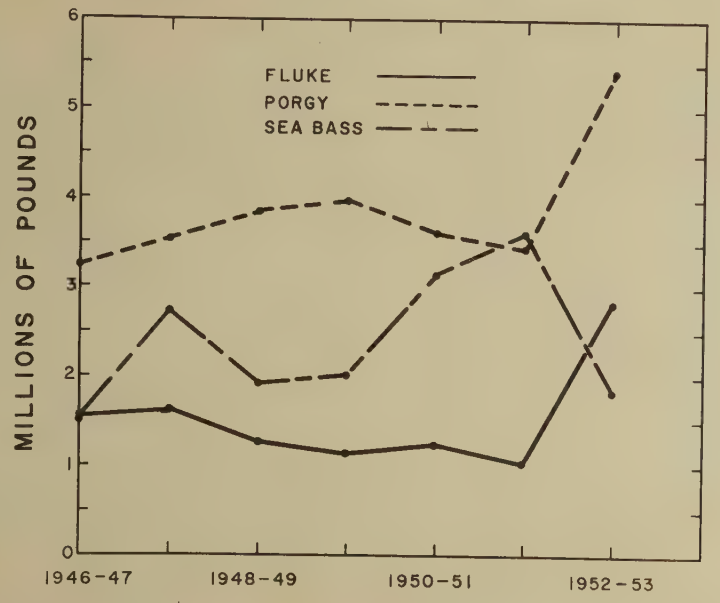

Figure 16.--Principal species, offshore otter trawl fishery, 1946-1953

Lobster Landings

Several vessels of the offshore fleet trawl for the northern lobster along the edge of the continental shelf from May through September. Monthly landings during recent summers average roughly 40,000 pounds. The catch is marketed in the coastal cities and resort areas in the middle Atlantic region. Market demands in these localities control production.

Lobster landings have contributed between 37,000 and 256,000 pounds a year to the otter trawl catch during the period 1947 through 1953 (fig. 17). Nearly all lobster landed during 1947, 1948, and 1949 were taken incidental to the fishery for foodfish. During 1950, 1951, and 1952, however, certain vessels trawled exclusively for this species during the summer months, contributing approximately 60 percent of the annual catch and, in 1953, more than 85 percent of the annual lobster landings came from these vessels.

Fishing grounds for lobster are in 80 to 120 fathoms of water where the bottom is very rough.

No detailed catch data are available for this fishery.

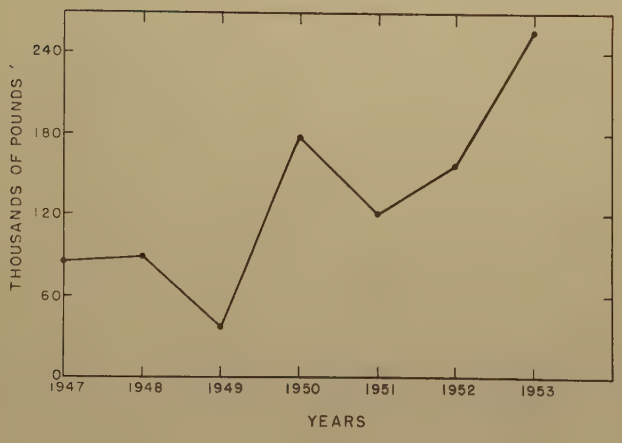

Figure 17.--Lobster landings, otter trawl fishery, 1947-1953

SCALLOP FISHERY

During the summer months some vessels from the offshore otter trawl fleet convert to scallop dredging within the survey area. While the catch is small, it is relatively important because of the high value of scallops. Landings of scallop meats at southern New Jersey ports in 1953 amounted to 293,000 pounds, with an estimated value of $146,500 to the fishermen. The bulk of the catch is landed from June to November, a period when otter trawling on the offshore grounds is relatively unproductive.

A description of gear and methods of fishing may be found in Royce (1947).

The principal grounds fished by the scallop fleet landing in southern New Jersey lie in the vicinity of the Hudson Canyon, off Barnegat, New Jersey, in 30 to 50 fathoms of water.

Estimated annual landings of scallops at southern New Jersey ports for the 7-year period, 1947 through 1953, are shown in figure 18. The bulk of the catch was landed by three to five vessels, operating regularly out of Atlantic City, Wildwood, and Cape May, New Jersey. The remainder of the catch was contributed by incidental landings of vessels usually landing at southern New England and Virginia ports.

No calculation of indices of abundance was made for this fishery due to the few vessels landing regularly in the area.

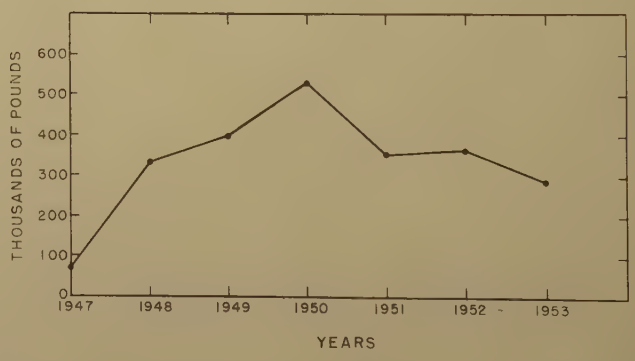

Figure 18.--Scallop fishery, estimated landings, 1947-1953

SURF CLAM FISHERY

The surf clam has become a major fishery resource in the coastal waters of southern New Jersey, Delaware, and Maryland. Following explorations in 1949, which disclosed extensive, virgin beds of these large molluscs in the sand shoals in the vicinity of Five Fathom Bank, a commercial fishery for canning purposes was established. From 1950 through 1953, annual production from these waters averaged nearly 500,000 bushels (5.7 million pounds of meats), valued at about $750,000 to the fishermen. Prior to 1950, the catch was utilized chiefly for bait in the sport and commercial fisheries in New Jersey, and total landings in the peak year, 1940, amounted to only 45,000 bushels.

The surf clam, or "skimmer", is the largest clam on the Atlantic seaboard, reaching up to 8 inches in length. This species is known to occur on the Atlantic coast of North America from Labrador to Cape Hatteras, but is exploited most intensively in the central part of its range. Surf clams live in beds on hard, sandy bottom, from shallow water to known depths of over 120 feet.

Vessels

The surf clam fleet is comprised of regular fishing vessels of the dragger type which have been converted for dredging purposes. Several Florida shrimp boats and one or two oyster boats have also been converted for surf clam operations. Vessels range in size from 31 to 78 feet in length and from 10 to 73 gross tons. Most are powered with diesel engines of 100 to 200 horsepower. They are operated by a crew of two to three men, depending on vessel size.

The size of the clam fleet varies because some vessels shift to clam dredging for a period and later change back to otter trawling. Of the 68 vessels that were engaged in the fishery at some time during 1953, only 46 operated consistently. The total number of vessels engaged in the fishery each year from 1950 through 1953 is given in table 8. The size of the fleet had nearly doubled over the 4-year period.

Fishing Gear and Methods

Surf clams are caught by means of a dredge consisting, essentially, of an iron frame that forms the mouth, an adjustable digging blade, a mesh bag for collecting the catch, and a hydraulic water system. The dredge is mounted on sled runners and towed along the bottom by means of a cable attached to a power-driven winch. Power for the water system is supplied by either a gasoline or diesel engine driving a centrifugal pump. A heavy duty rubber hose from 3 to 5 inches in diameter connects the pump with the dredge. An intake is provided by trailing a 6- to 8-inch diameter hose over the stern of the vessel. As the dredge is being towed along the bottom, numerous jets of water are directed downward, under pressure, in front of the blade. By this means the clams are loosened from the substrate and excess sand and debris washed off as the clams enter the mouth of the dredge.

Surf clam dredging is carried on throughout the year. Vessels make one day trips to the fishing grounds. Occasionally, during periods of favorable weather in the winter months, some of the larger vessels may spend two days at sea.

Most of the fishing is done in 90 to 100 feet of water. Some of the larger boats operate in maximum depths of 120 feet. Suitable bottom for operation of the dredge is located by means of a recording echo-sounder. The dredge is lowered over the side of the vessel and towed for a period of about 15 minutes. The mesh bag containing the catch is then hauled aboard and emptied on deck. If the tow was productive, the dredge is lowered for another tow while the catch is sorted and placed in coarse burlap bags. Each bag holds approximately 80 pounds of clams, or a bushel measure.

Fishing Grounds

The grounds fished by the New Jersey, Delaware, and Maryland surf clam fleets extend roughly from Atlantic City, New Jersey, to Winter Quarter Lightship, in 8 to 20 fathoms of water. Prior to 1950, clamming for bait purposes was confined to the ocean beaches of southern New Jersey. With the development of the canning industry, however, the importance of the offshore beds was recognized.

Table 8.--Summary data, surf clam fishery, 1950-1953

Year	Total number of vessels fishing	Number of vessels in select fleet	Percent of total used in the analysis	Total catch in bushels	Catch by vessels in select fleet in bushels	Percent of total catch landed by select fleet
1950	39	13	33.3	365,388	115,275	31.5
1951	51	30	58.8	484,269	298,818	61.7
1952	59	39	66.1	640,242	408,152	63.7
1953	68	33	48.5	642,005	351,775	54.8

The data summarized in figures 19 and 20 represent the amount of fishing effort (number of tows) expended by the fleets in 1952 and 1953, expressed in percent. Data for 1952 include the months of May through December only. Areas of heavy (greater than 10.0 percent), moderate (2.0 to 9.9 percent), and light (0.1 to 1.9 percent) fishing are indicated.

Grounds of importance to the fishery lie in the vicinity of the 10 fathom curve between Sea Isle City, New Jersey and lower Assateague Island, Maryland. Grounds most heavily fished are located off the mouth of Delaware Bay in the vicinity of Five Fathom Bank and Five Fathom Lightship and east-southeast of Ocean City, Maryland, in the area commonly known to the fishermen as the "Lumps", between Great Gull Bank and Jack Spot. Of the total fishing effort, 65 percent was spent in these areas in 1952 and 75 percent in 1953. It will be seen that the distribution of effort is similar for the two years, except that fishing extended farther offshore in 1953, in depths ranging up to 120 feet. Discussions with fishermen and cannery operators indicate that the largest clams occur in the deeper waters; present pumps and hoses limit the depths in which the dredges may be operated, however. It should be noted that no seasonal changes in the relative importance of the different grounds were indicated.

Catch

Figure 21 shows landings of surf clams from 1929 to 1953 for all years for which records are available. Since there was no fishery in Delaware or Maryland prior to 1950, production figures prior to that year are for New Jersey only. Subsequently, landings in Delaware and Maryland are included with New Jersey totals. The entire production of these three states originates within the survey area.

From 1929 to 1950, annual production averaged roughly 25,000 bushels, reaching a peak in 1940 when over 45,000 bushels were recorded. A drop in yield occurred during World War II when the party and charter boat sport fisheries were sharply curtailed, and the demand for surf clams as bait reached its lowest level. With the development of the canning industry in 1950, production climbed to over 365,000 bushels, or roughly ten times that of any previous year. The peak catch of 642,000 bushels was recorded in 1953.

Analysis of Data

Methods of computing catch per unit effort were identical to those used for the menhaden and trawl fisheries. The time unit selected was a month. The usual criteria for selection of vessels apply. A series of indices of catch per unit effort was obtained using 1950 as the base year. Pertinent data respecting the analysis are summarized in table 8.

Measurements of total yield, apparent abundance, and fishing effort are shown in figure 22. Over the 4-year period, 1950 through 1953, the calculated values indicate a steady downward trend in catch per unit effort while yield and fishing effort increased. If these indices may be assumed to reflect roughly changes which have occurred in the fishery, the interrelations of

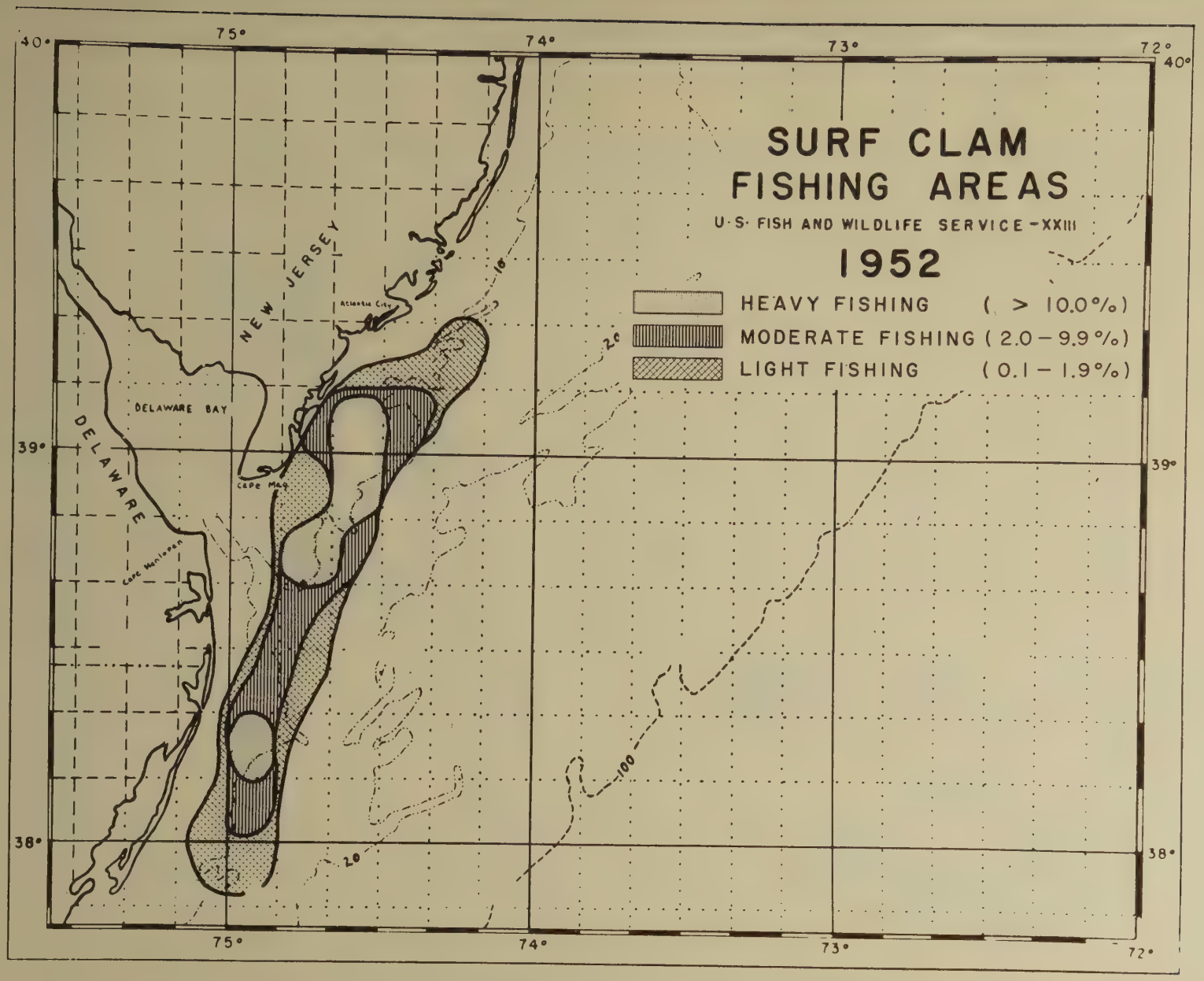

Figure 19.--Surf clam fishing areas, 1952

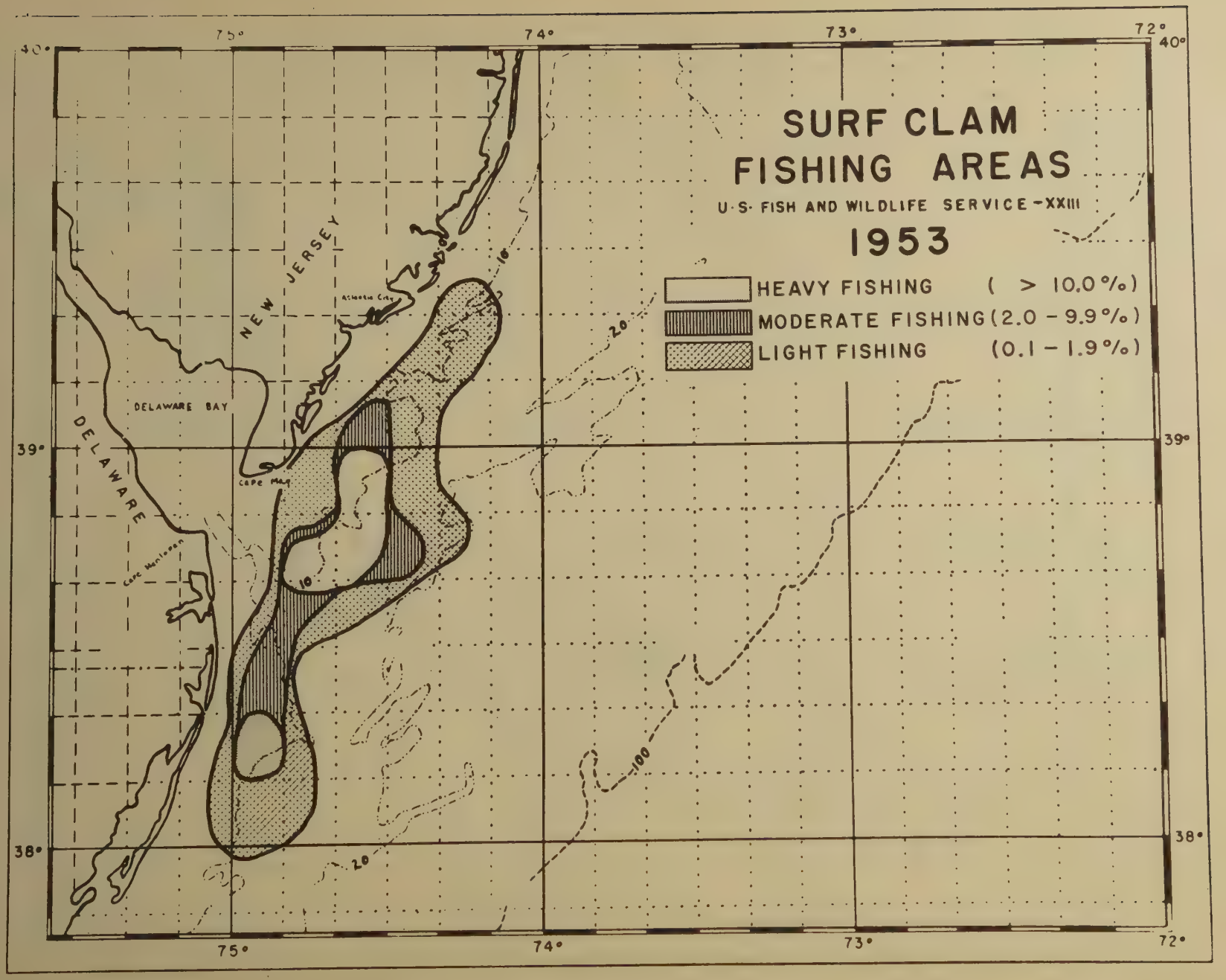

Figure 20.--Surf clam fishing areas, 1953.

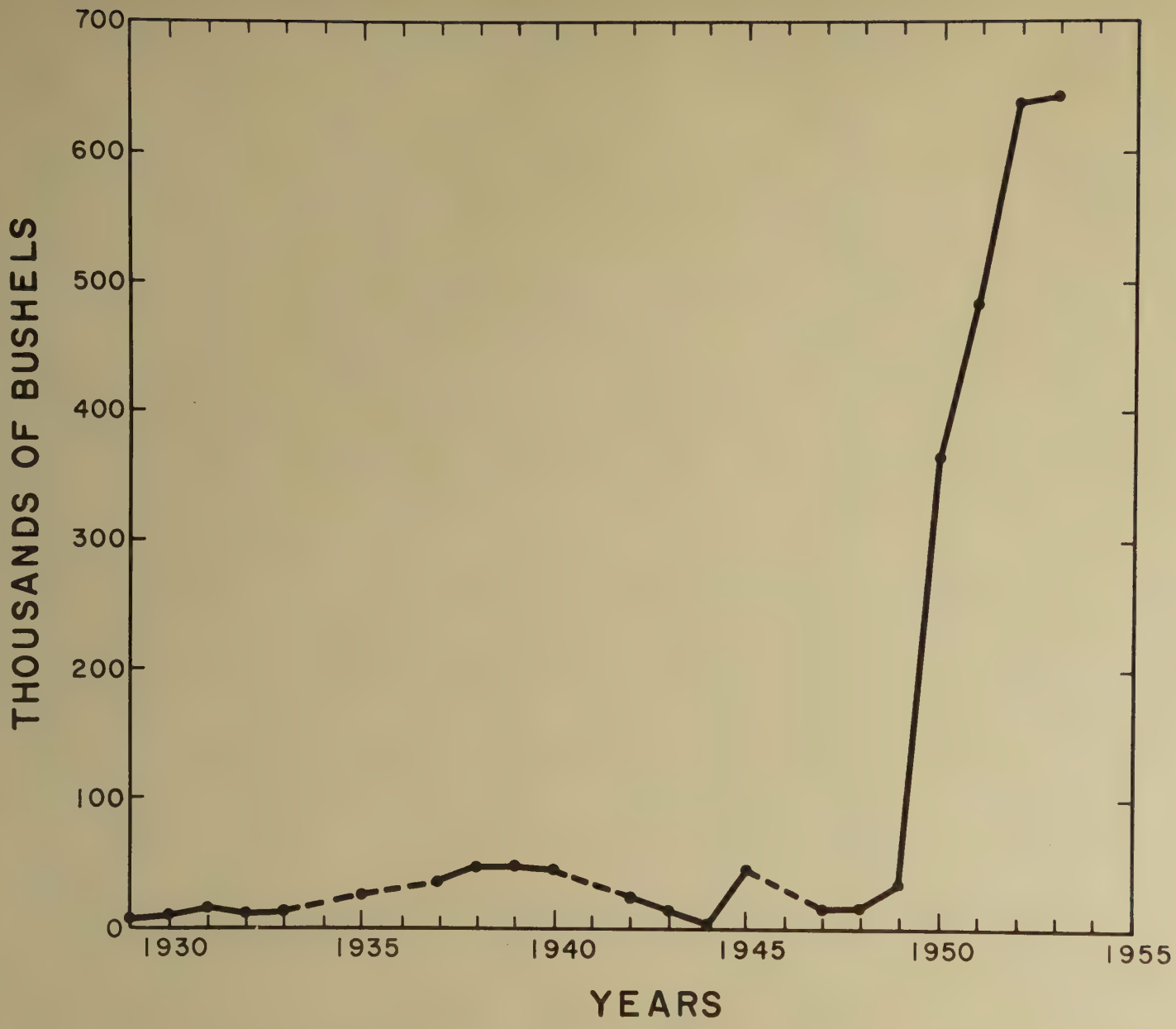

Figure 21.--Surf clam landings, 1929-1953

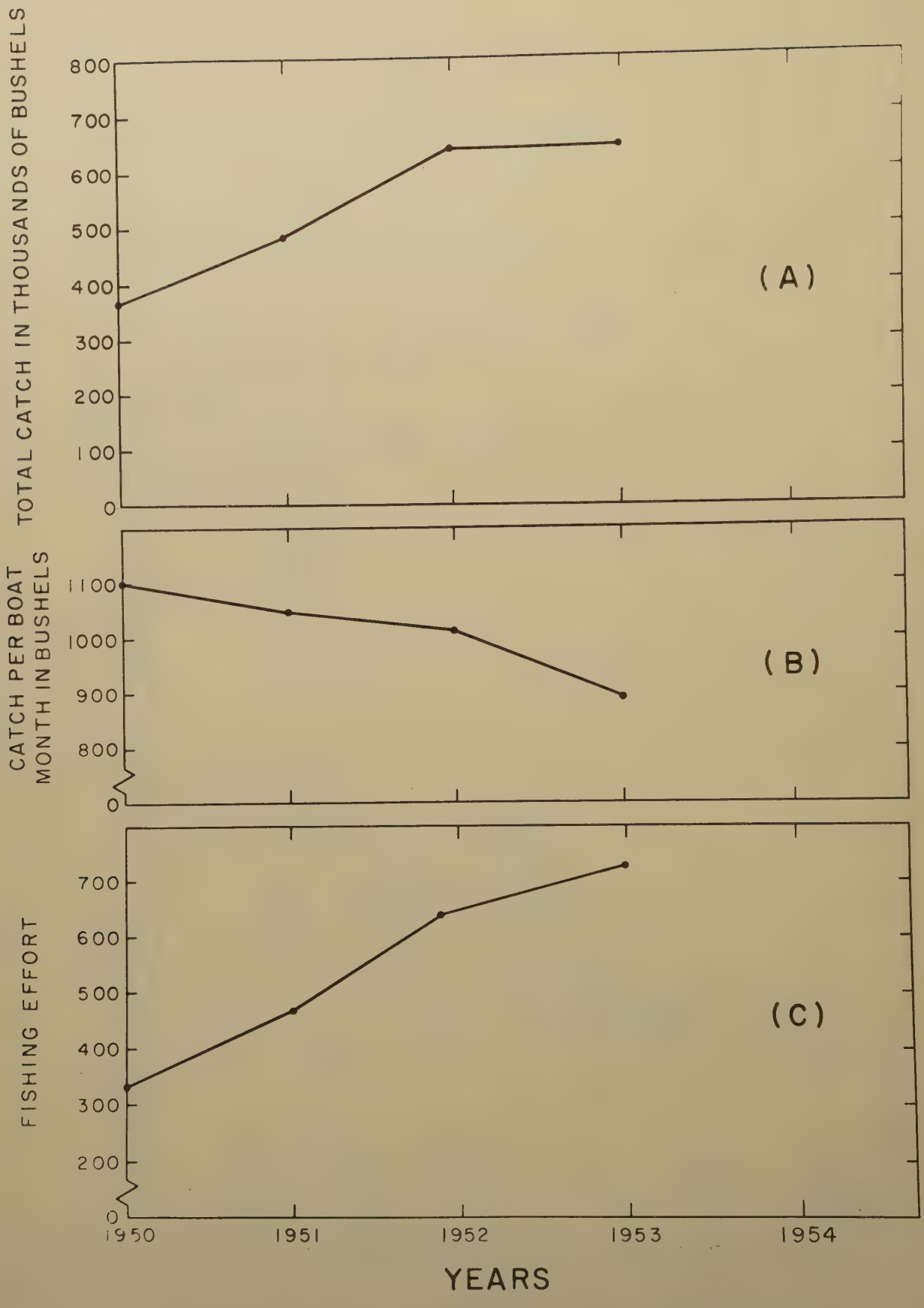

Figure 22.--Surf clam fishery; total catch, catch per unit effort, and fishing effort, 1950-1953

total catch, catch per unit effort, and fishing effort suggest that the productive level of the fishery has not stabilized, and the increase in yield was associated with an increase in fishing effort. The foregoing conclusions, therefore, indicate that some further decline in surf clam production is to be expected. It may be of interest to note that if the number of vessels continues to increase, catch per unit effort may continue to decline even though total landings may remain relatively high for a time.

PURSE SEINE FISHERY FOR FOODFISH

The purse seine is believed to have originated in Maine about 1837 and was first used for capturing menhaden (Goode, 1879) in Rhose Island waters. By 1860, a sizable purse seine fishery for mackerel was established in New England (Knake, 1950), yet it was not until 1900 that important quantities of porgy, weakfish, and croaker were taken by this gear in the middle Atlantic area.

Two purse seine fisheries for foodfish operate within the survey area. Commencing in late March or April, seiners from the New England mackerel fleet move into the waters off Delaware Bay to intercept the spring runs of mackerel as they move northward along the coast. These vessels return to their home grounds when the runs have passed. A small resident fleet, varying from two to five vessels, fishes for porgy and weakfish from May through October. In 1953, approximately 3.0 million pounds of foodfish were landed by the southern New Jersey purse seine fleet. The catch was valued at $150,000 to the fishermen.

Vessels

The seine vessel is from 60 to 110 feet in length and may be designed along the lines of a schooner, otter trawler, or modified World War I or II submarine chaser. It is characterized by a prominent crow's nest on the foremast and a towing boom on the starboard side.

Two additional vessels, a seine boat and a small dory, are used to set the New England mackerel purse seine. The seine boat is an open, power-driven boat, varying from 24 to 45 feet in length. Three additional vessels are used to set the middle Atlantic purse seine for foodfish, two seine boats and a spotting vessel. The latter is similar in design to a small otter trawl vessel. Most seine vessels employ a crew of from 11 to 14 men.

Fishing Gear and Methods

Purse seine gear for foodfish is similar to that employed for menhaden. The former varies from 160 to 190 fathoms in length and is usually about 900 meshes deep. Some of the newer nets are 1,200 meshes deep to allow for fishing in greater depths. Mesh size varies from 2 to 2-1/2 inches stretched measure.

The method of fishing for foodfish also differs somewhat from the menhaden operation. Since few schools of porgy, weakfish, and other food species are visible at the surface, fish are located by means of an echo sounder. After a school of fish has been located, the spotting boat remains over the school while the seine boats set the net. Pursing is accomplished by the seine boats. The spotting vessel then moves outside the net enclosure by passing over the cork line. Usually the spotting vessel stands by to receive some of the catch. Before the echo sounder came into use, schools of fish were located by their surface color, feeding birds, or the dark shadow cast by the school as it passed over the bottom. Occasionally chum was used to induce scattered fish to "school up" while the net was being set. Detailed description of the vessels, gear, and methods of fishing may be found in Knake (1950).

Fishing Grounds

Fishing grounds for the purse seine fleets occupy the narrow coastal strip within the 10 fathom curve. The appearance of mackerel, in these waters, has been so erratic that no regular fishing grounds for this species can be established. During past years of abundance, however, the waters just off the mouth of the Delaware Bay and in the vicinity of Five Fathom Bank, ranging in depths from 5 to 10 fathoms, were most productive.

Purse seining grounds for porgy and weakfish include the shallow, inshore waters and the

offshore shoals and banks less than 10 fathoms in depth. The areas off Barnegat, Brigantine, Sea Isle City, and in the vicinity of Five Fathom Bank are most heavily fished.

Catch

The purse seine fishery for mackerel has been characterized by violent fluctuations during the past 30 years. In 1949, over 16 million pounds of this species were landed in New Jersey ports by a large fleet of New England seiners (see fig. 23). The following year

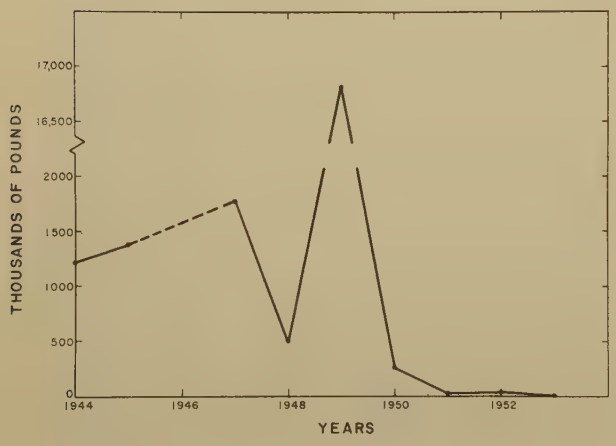

Figure 23.--Purse seine landings of mackerel, 1944-1953

a sizable fleet returned to southern New Jersey waters, but production totalled only 250,000 pounds. Since then, only one or two seiners have visited the area, landing only a few thousand pounds each season. Detailed catch data respecting the mackerel purse seine fishery were not available. Partial dock records for the period 1947 through 1953 indicate that nearly the entire New Jersey catch was made during the month of April.

Foodfish landings, exclusive of mackerel, by the southern New Jersey purse seine fleet for the 7-year period 1947 through 1953 are shown in table 9, and figure 24. Porgy was the most important species, accounting for about 87 percent of the catch for the 7-year period. Weakfish constituted about 11 percent of the yield. Annual production averaged roughly 2.2 million pounds. Other species included bluefish, croaker, striped bass, menhaden, butterfish, and sea bass. Fishing commences in May and continues through late October or early November (see fig. 25).

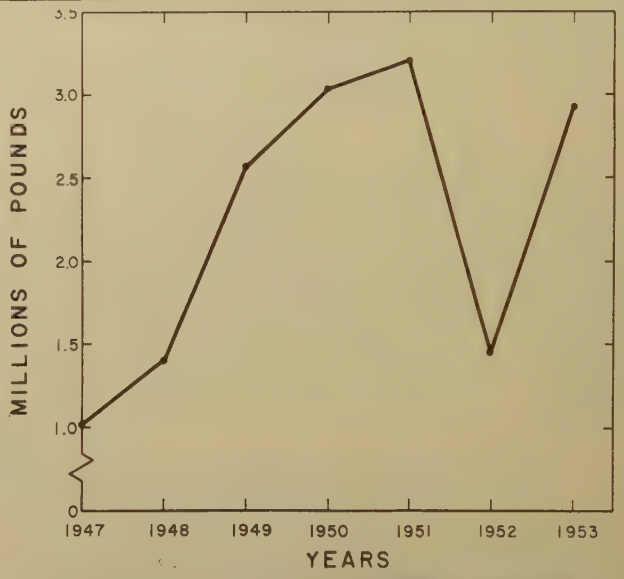

Figure 24.--Purse seine foodfish landings (exclusive of mackerel), 1947-1953

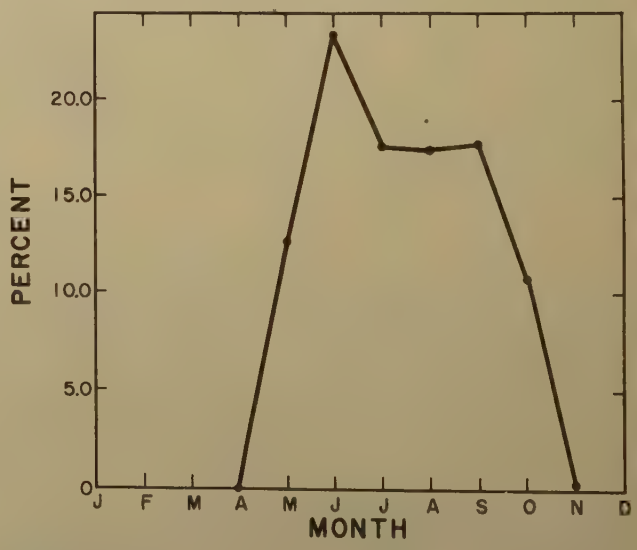

Figure 25.--Purse seine landings, in monthly percentages, 1947-1953

Table 9.--Purse seine landings of foodfish (exclusive of mackerel), in pounds, 1947-1953

Year	Porgy	Weakfish	Bluefish	Croaker	Striped bass	All others	Total
1947	392,700	587,900	23,800	---	---	4,900	1,009,300
1948	1,187,600	188,800	10,400	---	17,700	2,600	1,407,100
1949	2,247,400	297,800	22,300	---	---	7,500	2,575,000
1950	2,925,800	88,700	27,400	---	---	6,700	3,048,600
1951	3,116,000	68,200	8,600	---	---	7,800	3,200,600
1952	1,002,100	427,700	16,400	---	300	5,700	1,452,200
1953	2,719,300	120,800	22,500	50,300	9,200	12,900	2,935,000

The month of peak production is June.

Because of the paucity of data no index of abundance was calculated.

POT FISHERY

A pot fishery for sea bass developed in the middle Atlantic area about 1926 when certain lobster pot operators found a ready market for incidental landings of these fish. As lobster catches declined in New Jersey in the early 1930s, increasing numbers of lobster pots were modified for sea bass fishing. In 1953, approximately 2.0 million pounds of sea bass, valued at $240,000 to the fishermen, were taken in the area from Atlantic City, New Jersey, to just below Ocean City, Maryland. Although some sea bass are taken by pots in New York and Virginia waters, over 90 percent of the middle Atlantic catch originates in the coastal waters of southern New Jersey, Delaware, and Maryland.

Vessels

Vessels used by the pot operators range from 25 to 40 feet and are characterized by a large open deck occupying one-half to two-thirds of the after part of the vessel. A small winch is used to lift the pots. Both gasoline and diesel engines are used in the fleet, the former in the smaller and older boats. The crew consists of two men with often an additional deck hand during the period of heavy production in mid season. Twenty boats were engaged in the fishery in 1952 and 1953.

Fishing Gear and Methods

The pots or traps used in the sea bass fishery are patterned after the standard half-round lobster pot. There are two compartments with entrances provided by means of net funnels. The trap is approximately 48 inches long, 20 inches wide, and 15 inches high. Most operators fish about 15 pots in a string. They are spaced about 10 to 12 fathoms apart and fastened to a heavy trawl line, which is anchored and marked with surface buoys.

In late April, strings of pots are set in 12 to 18 fathoms of water on rocky bottom, often in the vicinity of wrecks. Bait is not used, although some operators use broken glass as a lure. Bricks are wired inside the pot to ensure proper settling. Each operator may fish from 250 to over 1,200 pots, but the usual number is about 500. The pots are lifted about once a week depending on the number operated. During late summer the pots are moved into greater depths and are normally removed from the water during late October and November.

Fishing Grounds

Location of fishing grounds for the 1952 and 1953 seasons are shown in figure 26. An estimated 85 percent of the sea bass landed by the pot fishery came from grounds lying immediately offshore of the 10 fathom curve, extending from just south of Ocean City, New Jersey, to Winter Quarter Lightship.

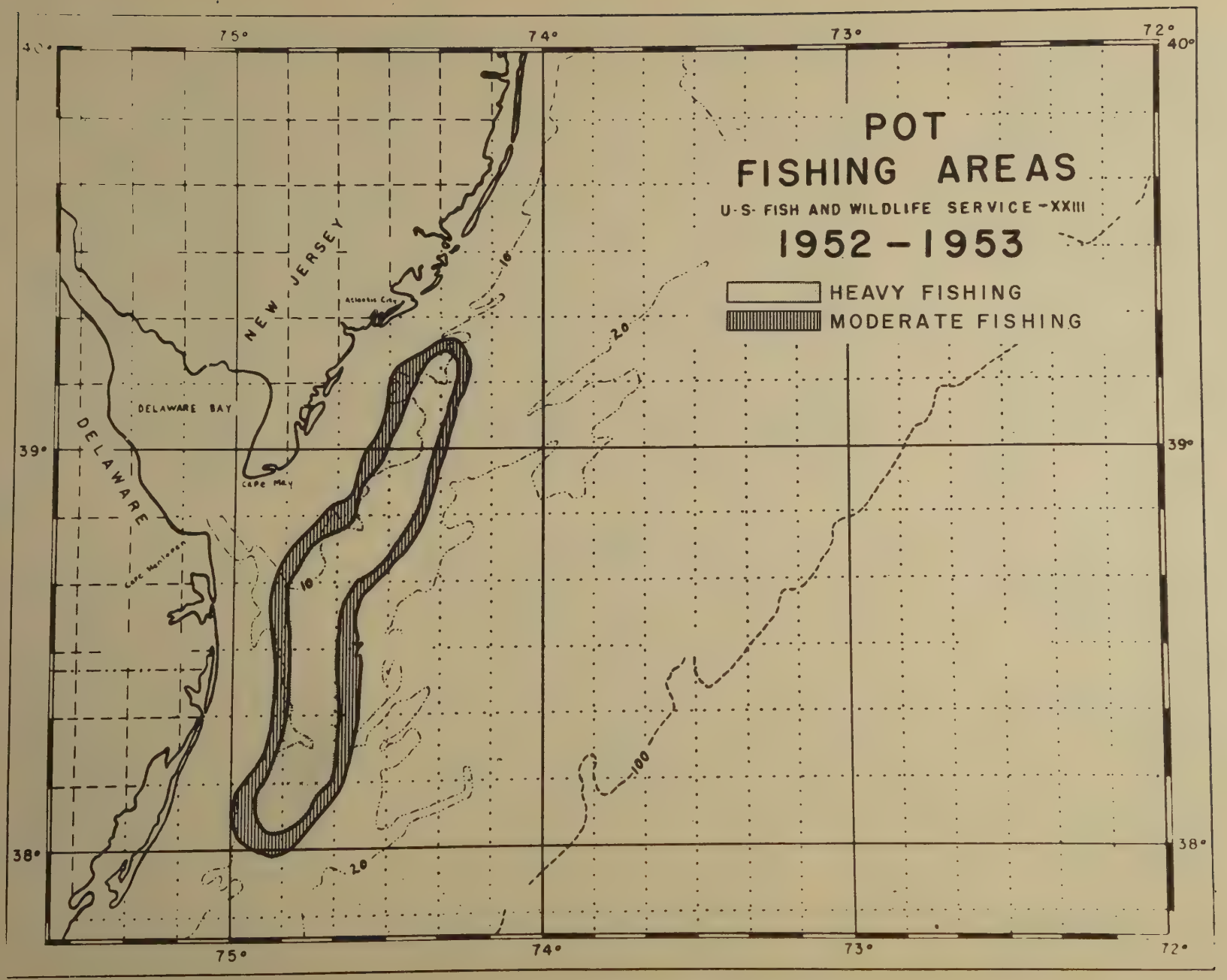

Figure 26.--Pot fishing areas, 1952-1953

Catch

Table 10 summarizes data pertaining to catch and species composition of the pot fishery for the period 1946 through 1953. Within the survey area, annual production for the 8-year period averaged over 1.5 million pounds. The principal species represented by "all others" included tautog, red hake, porgy, grunt, conger eel, and northern lobster.

Average monthly percentages of the catch for the period 1946 through 1953 are plotted in figure 27.

The total catch was rather steady from 1946 to 1951, but suddenly increased in 1952 and 1953. The catch per pot showed a marked increase over the 7-year period. In contrast, the amount of fishing declined somewhat. These data indicate that, apart from minor fluctuations, the average abundance of sea bass increased within the area during the period.

POUND NET FISHERY

For many years, pound nets were one of the principal gears used to exploit the migratory fish stocks in the inshore waters of the middle Atlantic coast. Recently, however, this gear virtually has disappeared in certain localities. Of the 14 fishing companies which operated an estimated total of 45 nets in the vicinity of Ocean City, Maryland, during the 1920s, not a single one remains. The last nets being fished out of Wildwood, New Jersey, were removed from the water in August 1953. Among five pound net companies located at Sea Isle City, New Jersey, only three expected to resume fishing in 1954.

Statistics on yield furnish a rough measure of the change in this fishery. Figure 29 shows pound net production for New Jersey from 1939 through 1952. The catch declined from 1944 through 1950. The sharp rise in the curve in 1951 was due to increased landings of menhaden which accounted for two-thirds of the catch. The following year this species comprised over half the total landings. Although a general decrease in yield was evident in the entire middle Atlantic region, commencing about 1944, the decline was

Table 10.--Pot fishery, total catch and catch composition, in percent, 1946-1953

Year	Catch in pounds	Percent sea bass	Percent all others
1946	1,400,000	96.5	3.5
1947	1,404,000	95.1	4.9
1948	1,460,000	95.6	4.4
1949	1,248,000	93.9	6.1
1950	1,486,000	94.9	5.1
1951	1,370,000	96.4	3.6
1952	2,172,000	98.2	1.8
1953	2,041,000	98.1	1.9

Figure 28 shows (1) total landings within the survey area; (2) the catch per pot per season; and (3) fishing effort in terms of number of pots fished.

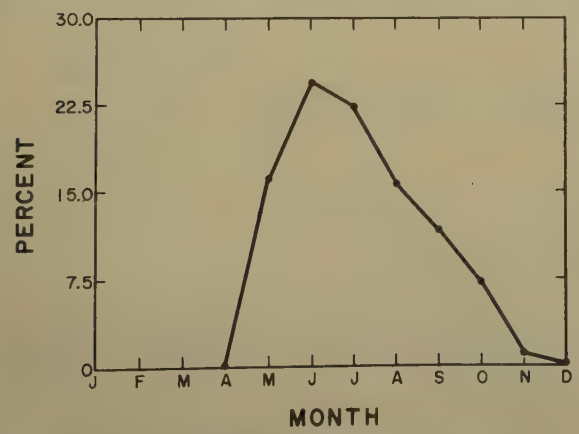

Figure 27.--Pot fishery landings, in monthly percentages, 1946-1953

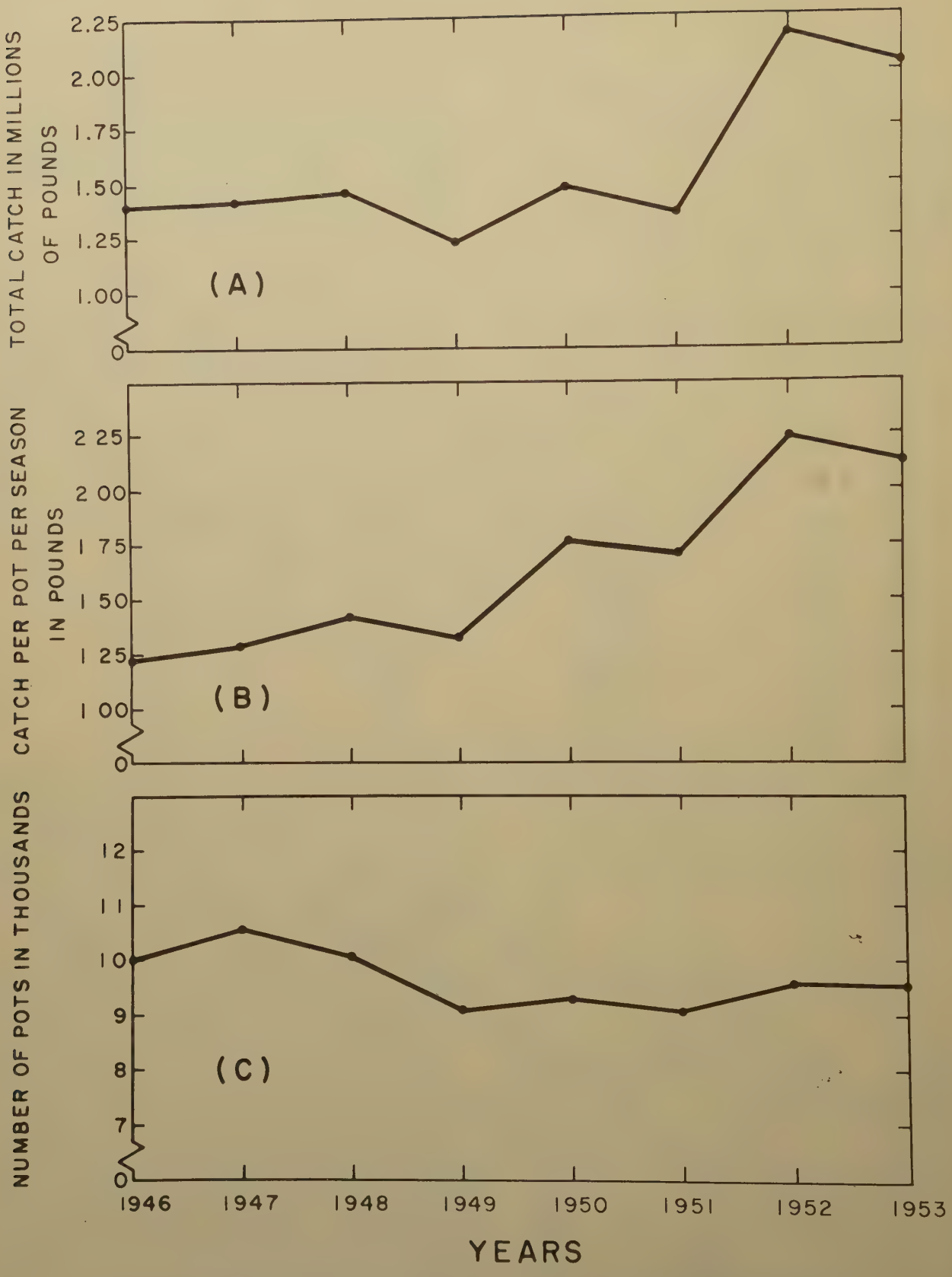

Figure 28.--Pot fishery; total catch, catch per unit effort, and fishing effort, 1946-1953

Figure 29.--Pound net landings, New Jersey, 1939-1952

most precipitous in certain restricted coastal areas. Most significant perhaps was the complete disappearance of the fishery at Ocean City, Maryland, in 1953. In figure 30 are charted the pound net landings at this port from 1944 through 1953. Apart from annual fluctuations, the most significant drop in production occurred in 1951 when landings fell below 100,000 pounds, less than one-twentieth that reported 7 years earlier. Within the survey area production in 1953 amounted to 981,000 pounds with an estimated value of $25,000 to the fishermen. Although of decreasing importance among the commercial fisheries within the survey area, information respecting the pound net fishery is presented here for historical reasons.

Figure 30.--Pound net landings, Ocean City, Maryland, 1944-1953

Vessels, Fishing Gear and Methods

Boats used for transporting the catch from the nets to the landing docks vary from 30 to 38 feet in length. They are powered with gasoline engines ranging from 40 to 115 horsepower. Though completely open, these boats are extremely seaworthy.

The pound net is a stationary gear set in shallow waters along the coast or on a fishing bank offshore. Webbing hung from wooden piling forms a leader which directs the fish into a V-shaped opening called the heart. The tendency of the fish to follow the webbing leads them into the pot or crib where they become entrapped. The catch is removed by lifting the floor of the pocket net in which the fish are confined. Weather permitting, the catch is removed daily except Sunday. During periods of heavy storms the nets may be removed from the piling to prevent damage or loss.

Pound nets usually are set in March or April and remain in the water until mid-October or longer, depending on the weather. In certain localities nets often are set only during periods when runs of certain species are expected. In northern New Jersey, for example, many operators fish specifically for menhaden from March or April until commencement of the menhaden purse seine season late in May.

Fishing Grounds

Pound nets formerly were located at numerous places along the southern New Jersey and Maryland coasts. Fishing success was dependent upon the selection of the most likely places for intercepting the various runs of migratory species that followed the shoreline or congregated in schools offshore, hence locations that proved successful were continued year after year. Pound net sites were limited, however, to those few localities where there were both depths and bottoms suitable for driving the piles. Five Fathom Bank was one of the most productive areas during the heyday of the fishery. The few remaining nets operated in 1953 were located about two miles offshore in the vicinity of Sea Isle City, New Jersey.

Catch

In figure 31 are shown pound net landings for the period 1949 through 1953, the only

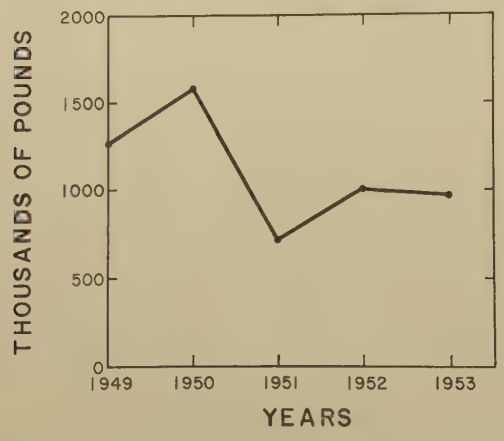

Figure 31.--Pound net landings, 1949-1953

years for which complete data were available. The annual yield during this period averaged about 1.1 million pounds. The principal species are listed in table 11. The percentage values represent the average for the 5-year period. The rank of individual species shifted markedly from year to year, although weakfish, butterfish, and menhaden consistently furnished the bulk of the catch.

Table 11.--Species composition, pound net fishery, 1949-1953

Species	Percent
Weakfish	37.2
Butterfish	23.6
Menhaden	14.7
Squid	3.1
Porgy	2.9
Mackerel	1.5
All others	17.0

No index of abundance was calculated.

The decline of the middle Atlantic pound net fishery has been attributed variously to a decrease in abundance of the migratory foodfish stocks, changes in hydrographic conditions which have adversely affected certain species, competition from mechanized gears, such as the otter trawl - to mention but a few diagnoses. A detailed discussion of the possible contributing factors is presented elsewhere (June, 1956). Suffice it to say that the pound net fishery of the middle Atlantic area faces an uncertain future.

DRIFT GILL NET FISHERY

Gill nets were one of the first types of net gear to be used commercially in the middle Atlantic area. They have never been of major importance in this region, however, since first introduced about 1835. While gill nets were used to catch a great variety of fishes, it was the drift net fishery for mackerel which over the years was pursued with greatest intensity. Relatively low investment costs in gear and vessel enabled many small operators to engage in the fishery.

Mackerel production in this area of the coast, as elsewhere, has fluctuated markedly. Annual gill net landings in New Jersey over the past 30 years have varied between 176,000 and 3.0 million pounds. The yield within the survey area in 1953 amounted to 246,000 pounds with an estimated value of $25,000 to the fishermen.

Vessels, Fishing Gear, and Methods

Vessels used in the mackerel gill net fishery off New Jersey, Delaware, and Maryland vary from small motor launches to medium-sized otter trawlers. Most vessels use a roller which is fastened to the stern or gunwale to assist in setting and recovering the nets. Although some of the larger vessels are equipped with a power winch for recovering the gear, most of the nets are pulled by hand. Each vessel is manned by two or three men.

Gill nets are designed to catch fish by the gills as they swim into the webbing. There are many variations in mesh size and dimensions, depending on the species sought. A mackerel gill net is approximately 180 feet long and between 8 and 10 feet deep. It consists of a vertical wall of cotton, linen, or nylon netting suspended from the surface by a cork line and weighted at the bottom by a lead line. Since proper fullness of webbing is important to the efficiency of the

net, about 75 percent more webbing is used than the length of the cork or lead lines.

From 10 to 50 nets are fastened together and set in a continuous string. Often during periods of poor fishing, from one to five nets are set for the purpose of locating runs of fish. Since mackerel nets are fished at night, their position in the water is marked by attaching a lighted buoy to every fifth net in the string. Since currents and wind affect the relative position of the nets and boat, a watch must be kept to prevent the nets from tangling. Nets nearest the vessel are lifted periodically to check the catch. If the set proves unproductive and time permits, the nets may be taken aboard and set in a different locality, but ordinarily they are not lifted until after sunrise. At the time of recovery the nets containing the catch are piled on deck, fish are removed and sorted at the landing dock.

Fishing Grounds

Grounds of importance to the mackerel gill net fishery lie in a continuous belt from 3 to 20 miles offshore in 5 to 15 fathoms of water. Areas of heaviest fishing, for the most part, are located in close proximity to the fishing ports. Activities of the fleet, however, are determined by the movements of the fish. In late winter and early spring, the first catches usually are made in the vicinity of Winter Quarter Lightship, off Chincoteague, Virginia, and fishing gradually moves northward along the coast. In late fall the first catches are usually made in the northern part of the area.

Catch

Estimated landings of mackerel by the drift gill net fishery within the survey area for the 8-year period, 1946 through 1953, are shown in figure 32. Annual catches during the period have averaged slightly over 1.0 million pounds. The poorest catch was in 1953 when less than 250,000 pounds were landed. It is of interest to note that the gill net catch of mackerel in 1949 did not show the marked increase in production shown by the purse seine fishery (see page 34).

Other species commonly occurring in the catches are bluefish, butterfish, red hake, sea herring, menhaden, mackerel shark, weakfish, and whiting. These are of little importance to the fishery, however (table 12).

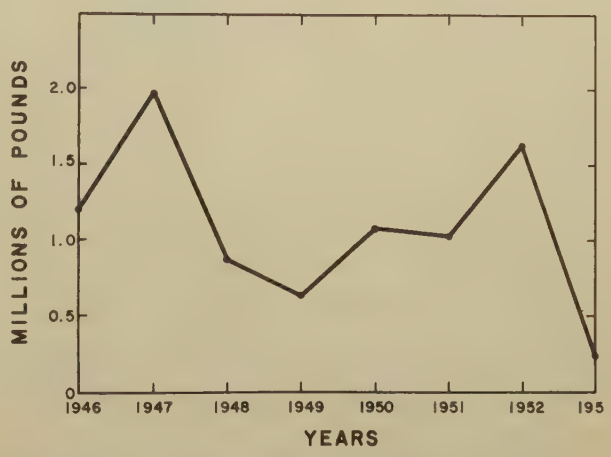

Figure 32.--Drift gill net landings of mackerel 1946-1953

The seasonal movements of mackerel in this area of the coast vary greatly from year to year creating a relatively unstable fishery. Table 13 shows the catch by month in percentages for the period 1946 through 1953. Prior to the 1949 season the bulk of the catch was landed in April and May. During the following three seasons, however, a winter fishery developed with most of the catch being taken from December through February. Whether this condition was brought about by changing oceanographic conditions, or other factors changing the habits of the fish, cannot be determined. There have been no apparent changes in fishing methods or marketing conditions during this period which might explain this seasonal shift.

Because of the erratic nature of the fishery, no index of abundance was calculated.

TRAWL LINE FISHERY

A winter fishery for cod, using trawl or trot lines, formerly was an important minor

Table 12.--Drift gill net fishery, total catch and catch composition, in percent, 1946-1953

Year	Pounds	Percent mackerel	Percent all others
1946	1,202,000	98.4	1.6
1947	1,997,000	99.4	0.6
1948	883,000	98.3	1.7
1949	642,000	96.9	3.1
1950	1,095,000	96.5	3.5
1951	1,030,000	97.5	2.5
1952	1,626,000	98.2	1.8
1953	246,000	94.8	5.2

Table 13.--Drift gill net landings of mackerel by months, in percent, 1946-1953

Season	November	December	January	February	March	April	May	June
1946-47	2.0	--	--	--	--	27.4	70.4	0.2
1947-48	0.5	--	--	--	--	23.4	76.0	--
1948-49	1.4	--	0.4	12.6	0.3	39.5	45.7	--
1949-50	--	9.5	14.6	28.7	4.1	20.5	22.5	--
1950-51	0.1	28.1	24.7	10.4	--	20.6	16.0	--
1951-52	0.1	11.4	25.5	33.5	2.0	18.5	9.0	--
1952-53	8.4	62.6	10.2	3.3	--	15.1	0.4	--

fishery within the survey area. Landings by this gear, however, amounted to less than 10,000 pounds in 1953 with an estimated value of $1,000 to the fishermen. The fishery is considered in this report principally on the merits of its past production. Should cod become abundant on the southern New Jersey fishing grounds, trawl lining again may become prominent among the minor fisheries.

Vessels, Fishing Gear, and Methods

Boats used for setting and hauling trawl lines usually are small motor launches varying from 20 to 35 feet in length. Their only distinctive feature is a roller, fastened on the stern, which is used in setting and recovering lines. Usually two men operate the gear.

The basic unit in trawl line gear consists of 500 hooks fastened at intervals to a ground or main line approximately 5,000 feet in length. These lines, together with the hooks, are coiled in half barrels or tubs. Usually 5 or 6 tubs of gear are set in a string, although some more ambitious operators have been known to set as many as ten. Hooks are baited with surf-clam meats.

Trawl lines are set shortly before dawn and allowed to fish for approximately two to five hours. The gear is set off the stern as the boat moves ahead. Keg buoys are attached between each tub of gear and also at the ends of the line. The time required to recover the gear, unhook the fish, and coil the lines in the tubs is approximately four hours depending on the size of the catch.

Fishing Grounds

Fishing grounds for cod are located over rough, rocky bottoms in depths of 8 to 15 fathoms. The areas of importance to the fishery are the

same as those for the pot fishery (fig. 26). The survey area marks the southern edge of the range for cod.

Catch

Total recorded production of cod by trawl lines within the survey area for the period 1946 through 1953 is shown in figure 33. From a peak of over 1.0 million pounds in 1946, the yield during the 8-year period declined almost steadily, and by 1953 had fallen to less than 10,000 pounds.

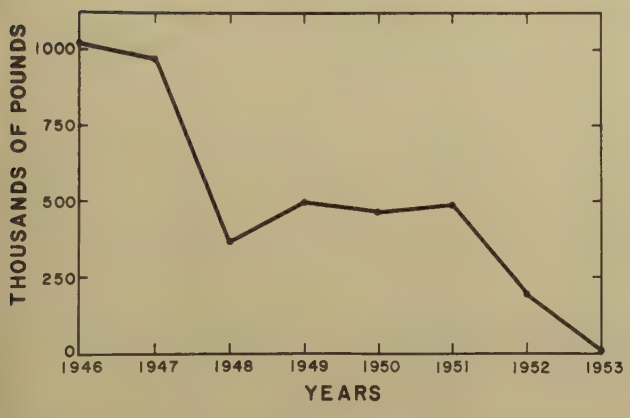

Figure 33.--Trawl line landings of cod, 1946-1953

Cod is the important species among the fishes taken by trawl lines within the area. Red hake, white hake, whiting, conger eel, tautog, anglerfish, skates, and sharks occur in the catch. Over the period considered, however, the combined catch of all other species did not exceed one percent during any year.

The fishery is pursued from November through April, with January and February representing months of peak production (fig. 34).

No index of abundance was calculated for the trawl line fishery.

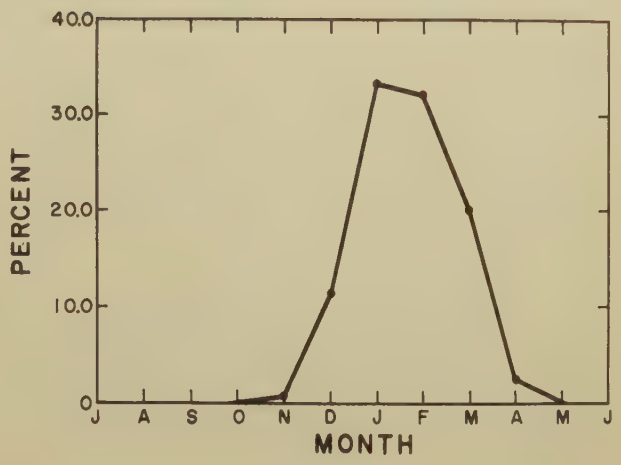

Figure 34.--Trawl line landings, in monthly percentages, 1946-1953

HAND AND TROLL LINE FISHERIES

Hand- and troll-line fishing from small boats have been two of the common methods employed commercially along the Atlantic seaboard since colonial times. A great number of part-time and seasonal fishermen contribute to the catch using these simple methods. In 1953, the estimated total production by hand and troll lines within the survey area amounted to about 170,000 pounds with an estimated value of nearly $30,000 to the fishermen.

Vessels, Fishing Gear, and Methods

Vessels, construction of gear, and methods of fishing vary considerably in different localities, and no generalized account would satisfy the numerous innovations. Motor launches and various other small power boats up to about 35 feet in length are used. In addition, pot, charter, and party boats are employed in these fisheries when not engaged in their primary activity. The only special equipment required are the outriggers for attaching the troll lines and a meat grinder for preparing chum.

Three types of gear are discussed in the following account. These include hand, jig, and troll lines. The hand line consists of a single length of line with one or more hooks attached by snoods or spreaders with a lead weight fastened at the end. When fishing for porgy, sea bass, and other bottom fishes, the hooks are baited with clam, squid, or cut fish, and hung just above the bottom in the vicinity of wrecks or over rough grounds. A large number of lines may be fished simultaneously over the side of the boat as it drifts or is anchored over the fishing grounds.

A jig consists of a number of hooks fastened to shorter lines than those used for bottom fishing. Usually they are not weighted. The lines are jerked or jigged up and down in the water as the boat drifts with the current or lies anchored over the grounds. Usually ground chum, consisting of fish, clam, or meat, is thrown into the water to attract the fish. In this area, the method is effective for most food species, including bluefish, bonito, mackerel, tuna, and weakfish.

Trolling gear consists of hooks and lines which are towed through the water. Two or three lines may be fished over the stern, but additional lines require the use of outrigger booms. Artificial lures or hooks baited with squid or fish are commonly used. Ground chum also may be used to attract the fish to the vessel. The largest catches usually are taken from schools of fish by crossing and recrossing their line of travel. Commercially, trolling is used for taking bluefish, bonito, and tuna in this area.

Fishing Grounds

Fishing grounds extend from the shallow waters along the beach to about 25 miles offshore. Because boats used in the fishery are small, areas most heavily fished are near principal ports of landing. Wrecks, rocky bottoms, and inshore shoal areas are most productive for bottom fishing. Trolling for pelagic species is carried on along the offshore ridges and shoals in the vicinity of tide and current boundaries. Jigging is pursued inshore near jetties and bays or in deeper water over the shoals. Figure 37 showing areas fished by the sport fishing fleets, is applicable to these fisheries, as the species sought and methods employed are the same. Certain major shoals, such as Brigatine, Avalon, Five Fathom Bank, McCries, Fenwick Island, Isle of Wight, Ocean City, Gull, Jack Spot, and Winter Quarter are the principal grounds within the survey area.

Catch

Commercial hand and troll line landings for the period 1946 through 1953 are summarized in table 14. The yield shown for 1946 is estimated from incomplete dock records. Annual production for the period average 166,000 pounds. The peak in 1948 was attributable to increased troll landings of bluefish which amounted to nearly 172,000 pounds.

Table 14.--Hand and troll line landings, 1946-1953.

Year	Hand-line catch in pounds	Troll-line catch in pounds
1946	75,000	23,000
1947	124,000	65,400
1948	92,100	171,600
1949	137,500	65,000
1950	28,400	125,900
1951	24,800	78,000
1952	28,700	119,600
1953	41,900	127,700

Average percentage composition by species for the 8-year period, 1946 through 1953 is shown in table 15. Sea bass, porgy, and weakfish comprised over 75 percent of the hand line catch, whereas bluefish was the important species in the troll fishery. In earlier years, substantial quantities of mackerel were taken by those methods; since 1946 this species has been of little importance.

Fishing with hand and troll lines is confined to the period from late spring until early winter. Figure 35 shows the monthly average percentage distribution of landings for 1946 through 1953.

No index of abundance was calculated for this fishery.

Table 15.--Species composition, hand and troll line fisheries, 1946-1953

Hand line		Troll line	
Species	Percent	Species	Percent
Sea bass	34.1	Bluefish	92.2
Porgy	23.5	Bonito	5.9
Weakfish	19.3	Mackerel	1.0
Fluke	7.9	Little tuna	0.4
Croaker	6.7	Bluefin tuna	0.4
Striped bass	2.4	Dolphin	0.1
All others	6.1		

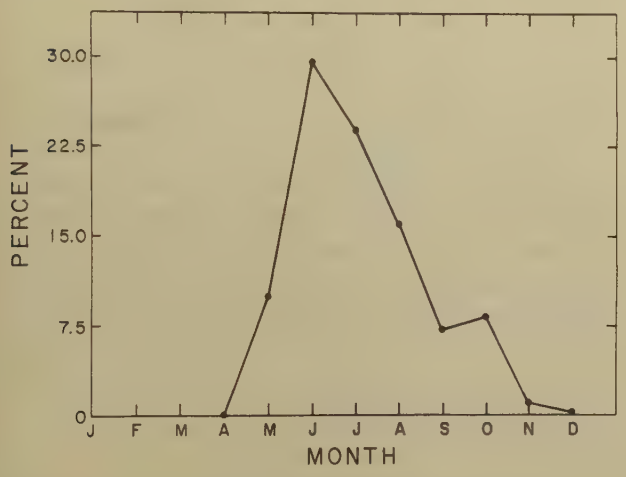

Figure 35.--Hand and troll line landings, in monthly percentages, 1946-1953

SPORT FISHERY

Vessels, Fishing Gear, and Methods

Vessels of the party and charter fleet typically are cabin cruisers ranging from 25 to 45 feet in length and powered with gasoline or diesel engines. All have radio telephones and some are equipped with recording depth-indicators. Trolling outriggers are standard equipment on most charter boats. No clearcut distinction can be made between charter and party boats. In general, charter boats are contracted for a day's fishing by a small group of fishermen. A party boat, on the other hand, charges a set fee per person.

In general, the gear and methods employed in sport fishing are similar to those of the commercial hand and troll line fisheries. Descriptions of vessels, gear, and methods of fishing may be found in Buller and Spear (1948) and Earle (1940).

No critical analysis of data regarding the sport fisheries will be attempted. Summarized information will be presented concerning yield, catch per unit effort, catch composition, fleet size, and other pertinent features. Measures and trends in abundance of the various fish stocks concerned have been discussed in foregoing sections.

Ocean City, Maryland

A charter and party boat fishery became established at Ocean City in 1934. The following summer the first white marlin was taken in that area and development of a charter boat fishery for this species thereafter was rapid. The fleet increased from 12 vessels in 1936 to 39 in 1939 and remained approximately this size until the 1942 season. The fishery was inactive from 1942 through 1944. In 1945 wartime restrictions were relaxed and a moderate-sized fleet was assembled. The fleet varied from 25 to 40 boats during the period 1946 through 1953.

The charter boat fishery may be considered as constituting three separate fisheries, each seeking a different fish or group of fishes and employing different methods and grounds. During May and early June many of the charters consist of large parties of 6 to 12 persons who fish for porgy, sea bass, and other bottom species on the inshore grounds. The remainder of the charters during this period are parties of 4 to 6

persons who troll for bluefish and other pelagic species on grounds up to 20 miles offshore. From late June through mid-September, small parties of two to four persons search for marlin on the offshore grounds, lying up to 40 miles from land. Approximately 50 percent of the charters during this period are exclusively for this species. Many small landings of bluefish, bonito, little tuna, dolphin, and other pelagic species, however, are the result of unsuccessful white marlin trips. On such trips most of the time and effort are spent trolling for marlin. If none is caught, the remaining part of the day's fishing may be devoted to trolling for other species.

Data concerning the Ocean City sport fishery were obtained from interviews and fishing logbooks kept by the boat captains. Detailed logbook information was available for approximately 55 percent of the fleet in 1952. Because of the homogeneity of data, the sample was reduced by one-half in 1953. Resulting data are summarized in table 16. The estimated total yield for the charter boat fishery in 1953 amounted to over 400,000 pounds. In addition, two party boats landed an additional estimated 50,000 pounds.

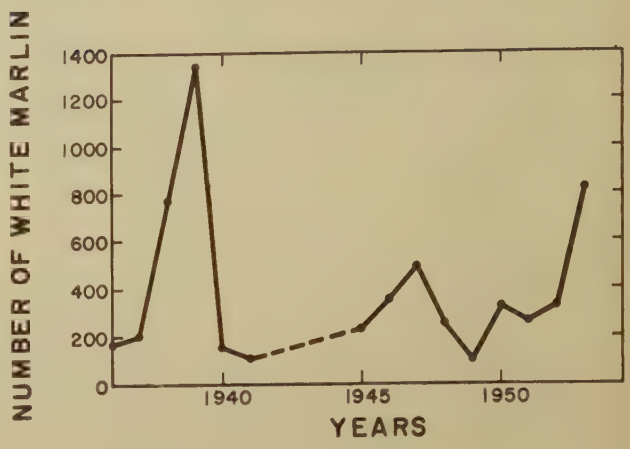

Figure 36.--White marlin landings, Ocean City, Maryland, 1936-1953

The objective in ocean sport fishing usually is recreational, and the resulting catch often is of secondary importance. This recreational aspect is particularly pertinent in the fishery for the larger game species. In addition, many of the smaller pelagic fishes are relatively unpopular as food, and the size of the catch often is controlled by the whims of the fishermen.

Table 16.--Summary data, Ocean City charter boat fishery, 1952-1953

	1952	1953
Number of boats	27	36
Estimated total number of trips	2,004	2,531
Average number of hours per trip*	5.0	5.1
Average number of fishermen per trip	4.4	4.8
Estimated total catch in pounds	277,000	401,000
Number of pounds per trip	138	158
Pounds per fisherman	31.4	32.9
Pounds per fisherman per hour	6.3	6.5

* Hours actually fishing

Species composition of the sport catch for 1952 and 1953 is given in table 17. It may be seen that bluefish was most important in both years among the pelagic species, and porgy was the leading bottom fish in the catches. By way of interest, the white marlin catch for the period 1936 through 1953, as recorded by the Ocean City Marlin Club is shown in figure 36.

Any calculated measure of fish abundance may have little biological meaning.

The grounds fished by the Ocean City fleet are shown in figure 37. The area encompasses approximately 700 square miles from Fenwick Island Light to Winter Quarter Lightship, extending about 40 miles offshore. Bottom fishing

Table 17.--Species composition, Ocean City charter boat fishery, 1952-1953

Species	1952 Percent of catch by numbers	1952 Percent of catch by weight	1953 Percent of catch by numbers	1953 Percent of catch by weight	Average weight/fish
Bluefish	75.8	73.4	50.1	56.3	2.5
Bonito	3.0	4.7	7.8	14.0	4.0
Dolphin	1.2	2.0	0.6	1.1	4.3
Little tuna	3.2	6.1	0.1	0.2	5.0
Porgy	14.6	4.5	39.4	14.2	0.8
Sea bass	0.4	0.2	0.7	0.3	1.0
Bluefin tuna	0.1	0.2	0.4	0.7	4.0
Weakfish	0.5	0.2	0.4	0.1	0.8
White marlin	0.3	8.2	0.5	13.5	65.5
All others	0.4	0.5	0.2	0.2	---

for porgy and sea bass is confined to the wrecks in the vicinity of Fenwick Island, Isle of Wight, Gull, Winter Quarter, and to shoals lying no more than 10 miles offshore. Trolling for bluefish and other small, pelagic species is conducted throughout the area, generally on grounds within 25 miles of the coast. Trolling for marlin usually is conducted from 15 to 40 miles offshore.

Delaware

Ocean sport fishing centers in Delaware are located at Lewes and Indian River. Vessels from the former port operate in both the ocean and in Delaware Bay, whereas, the Indian River fleet fishes exclusively in the ocean. In addition to the party boat fishery, ocean surf fishing occurs from Cape Henlopen to Fenwick Island.

Data respecting activities of the party boat fishery during 1952 were tabulated by source of catch, either ocean or bay. In 1953, however, the Indian River and Lewes fleets were treated separately. Summary analyses are presented in table 18. Due to an inadequate sample of the Lewes fleet in 1953, the results were reported in actual recorded figures, and no estimates of total effort or catch were made. Furthermore, survey data included numbers of fish only. However, using average weights obtained from the Ocean City, Maryland fishery by the authors, it was estimated that the Delaware sport catch in 1952 amounted to over 2.0 million pounds, and in 1953, 1.5 million pounds.

Species composition of the 1952 and 1953 catches is presented in tables 19 and 20. In table 19, the 1953 data include the estimated total for the Indian River fleet only. In table 20, on the other hand, are presented the recorded catch and species composition for the Lewes fleet, irrespective of origin of catch. The sea bass was the leading species in both years, in both the Indian River and Lewes fisheries.

From the published data, a simple index may be calculated for the ocean party boat fishery in terms of fish per man hour, or pounds per fisherman per hour. In 1952, the average catch for all ocean party boat fishing was 6.7 fish per man hours, or in terms of our estimated poundage, 5.4 pounds per fisherman per hour. In 1953, the average catch for the Indian River fleet was 4.1 fish per man hour, or 3.3 pounds per fisherman per hour.

In 1952, a surf fishing survey was conducted along Delaware beaches from Roosevelt Inlet to Fenwick Island. During the period from mid-June until mid-September, 8,200 fishermen caught 15,700 fish in 34,100 hours of fishing, or 0.46 fish per man hour. Species composition of the surf fishery catch for 1952 is shown in table 21.

Table 18.--Summary analysis, Delaware party boat fishery, 1952-1953

Year	Length of season	Number of boats	Number of fishermen	Man hours	Number of fish
1952	5/15-10/20	144	60,800	408,500	2,720,000
1953					
Indian River	6/3-9/30	101	31,740	450,000	1,825,000
Lewes	6/3-9/30	28		18,395	46,368

Table 19.--Species composition, Delaware party boat fishery, 1952-1953

Species	1952 Number	1952 Percent	1953 Number	1953 Percent
Bluefish	19,900	0.7	74,000	4.1
Bonito	5,000	0.2	37,000	2.0
Croaker	19,500	0.7	403,000	22.1
Fluke	2,400	0.1		
Little tuna	7,700	0.3		
Porgy	635,000	23.4	111,000	6.1
Sea bass	1,987,000	73.0	1,200,000	65.7
Tautog	24,400	0.9		
Weakfish	8,300	0.3		
Miscellaneous	10,000	0.4		
Total	2,720,000		1,825,000	

Table 20.--Species composition, Lewes party boat fishery, 1953

Species	Number of fish	Percent
Sea bass	26,770	57.7
Croaker	9,206	19.9
Porgy	4,648	10.0
Weakfish	4,098	8.8
Tautog	1,646	3.6
Total	46,368	

Table 21.--Species composition in numbers of fish, Delaware surf fishery, 1952

Species	Percent
Bluefish	2.5
Croaker	1.9
Fluke	4.5
King Whiting	17.8
Sand perch	5.1
Sea bass	1.3
Spot	3.8
Weakfish	33.1
Trash*	26.7
All others	3.2

*Principally skates, sharks, and sea robin.

No survey of the surf fishery was conducted during 1953.

Survey data did not include the area of capture for the party boat fishery in Delaware. Interviews, however, have confirmed the information shown on figure 37. Certain localities are fished more intensively than others. In general, the waters between 2 and 15 miles offshore, particularly in the vicinity of shoals and wrecks, are most heavily fished. Surf fishing occurs along the beach.

Southern New Jersey

An inventory of the New Jersey saltwater sport fishery was undertaken by the New Jersey Division of Fish and Game in 1952 with the objective of determining its biological and economic importance. Data pertinent to the present survey were made available by that agency. The portion of the New Jersey inventories of interest in the present report include the surf, party, and charter boat fisheries of southern New Jersey from New Gretna, just north of Atlantic City, to Cape May.

Previous reports concerning the charter and party boat fisheries of the region have been published by Moore, et al. (1938), Westman and Neville (1942), and Buller and Spear (1948).

The principal party boat fleets of southern New Jersey are located at Atlantic City, Wildwood, and Cape May. A summary analysis of the fishery for 1952 and 1953 is given in table 22. A marked decrease in fleet size occurred in 1953, accompanied by an apparent decline in the catch per fisherman. Species composition of the catch is summarized in table 23. In 1952, porgy and sea bass accounted for about 96 percent of the landings of this fleet. In 1953, however, fluke contributed substantially to the catch. Whether the decline in porgy landings in that year was associated with an increased effort for fluke was not determined.

Table 22.--Summary analysis, southern New Jersey party boat fishery, 1952-1953

	1952	1953
Number of party boats	147	82
Average number of fishermen per trip	21.4	19.5
Number of fishermen interviewed	2,510	2,374
Number of fish caught	42,604	29,448
Number of fish per man	17.0	12.4

Table 23.--Species composition in numbers of fish, southern New Jersey party boat fishery, 1952-1953

Species	Percent 1952	Percent 1953
Bluefish	0.4	
Fluke	0.6	22.3
King whiting	0.1	
Porgy	64.8	31.9
Sea bass	31.1	43.1
Tautog	2.9	0.8
Weakfish		0.7
All others	0.1	1.2

The charter boat fishery of southern New Jersey is relatively small, employing only 18 boats in 1952 and 16 in 1953. The charter boats of southern New Jersey operate much like the

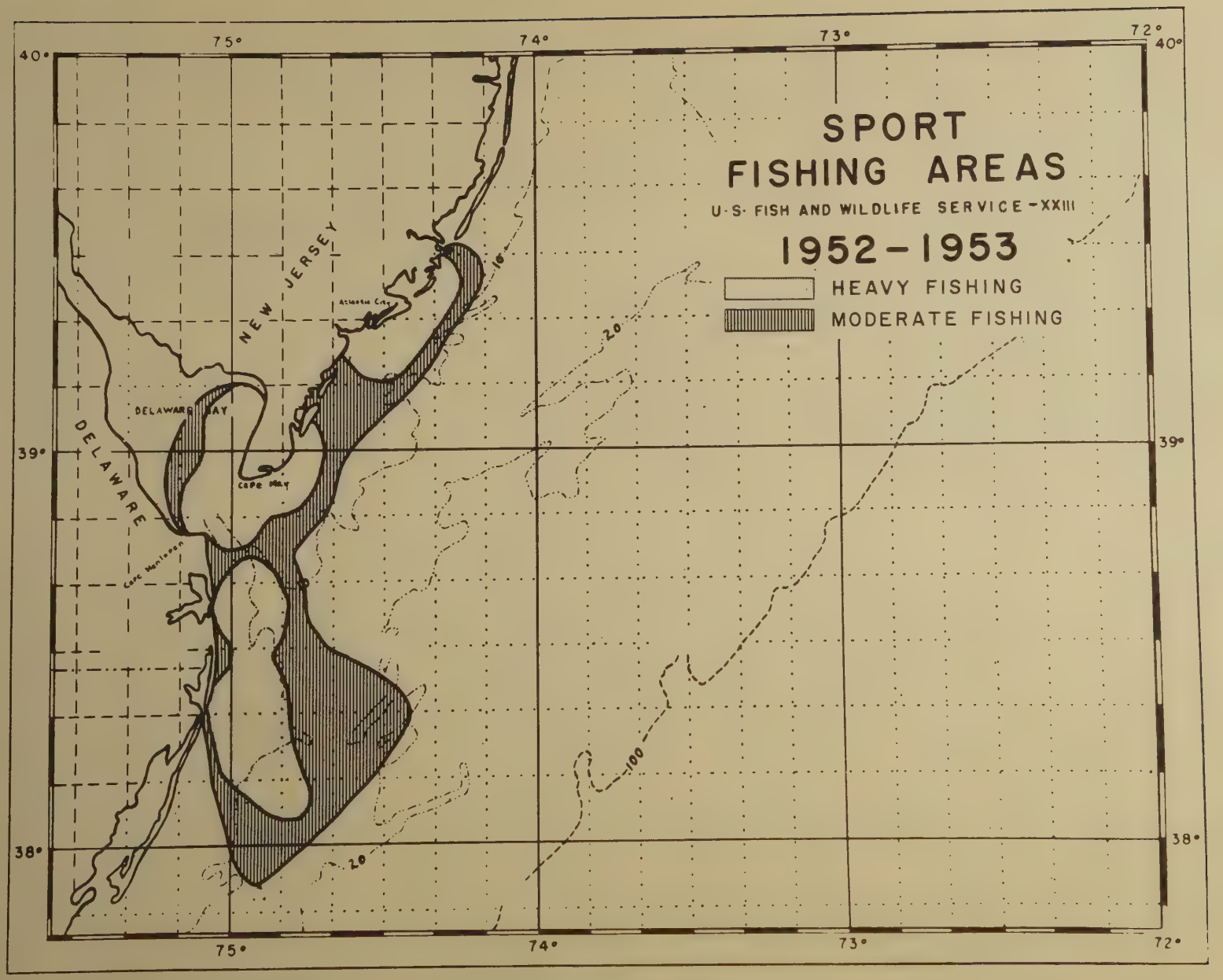

Figure 37.--Sport fishing areas, 1952-1953

smaller party or head boats. A summary analysis of the fishery for 1952 and 1953 is presented in table 24. It may be seen that there was little apparent change in the fishery over the 2-year period. Smaller parties and a slightly greater catch per fisherman were indicated in 1953. As shown in table 25, bluefish and bonito dominated the catch in 1953. The larger percentage of weakfish in 1952 indicates that a large number of catches from Delaware Bay were represented among the sample data. Results of the survey were tabulated by landing port rather than by origin of catch.

Table 24.--Summary analysis, southern New Jersey charter boat fishery, 1952-1953

	1952	1953
Number of charter boats	18	16
Average number of fishermen per trip	6.5	4.5
Number of fishermen interviewed	114	163
Number of fish caught	920	1,752
Number of fish per man	8.1	10.7

Table 25.--Species composition in numbers of fish, southern New Jersey charter boat fishery, 1952-1953

Species	Percent 1952	Percent 1953
Bluefish	13.3	41.0
Bonito		43.7
Fluke	7.6	7.0
King whiting	8.3	
Little tuna	8.7	
Porgy	3.0	1.8
Spot	1.3	
Bluefin tuna	0.5	
Weakfish	51.9	4.7
All others	5.3	1.8

Combined data from the party and charter boat fisheries are presented in table 26 to show the comparative abundance of the six principal species in 1952 and 1953. Only those catches consisting of two-thirds or more of a single species were used. It may be seen that small fluctuations occurred among five of the species. Most noteworthy, however, is the complete disappearance of mackerel from the catches in 1953.

Incomplete interview data for the area indicated that surf fishing in 1952 produced 551 fish for 1,024 fishermen, or 0.54 fish per man. In 1953, 362 fishermen landed 360 fish or 0.99 fish per man. The percentage composition of the catches is shown in table 27. No explanation is offered for the shift in importance of the various species.

Party and charter boat fishing grounds extend along the entire southern New Jersey coast, but usually are confined to less than 25 miles from land. The areas in the immediate vicinity of the principal ports are most heavily fished (see fig. 37).

Surf fishing occurs along all ocean beaches within the area.

CONCLUSIONS

1. A survey of the ocean fisheries being prosecuted in the region lying between Barnegat and Winter Quarter lightships indicated that this is one of the most productive coastal regions in North America. In 1953, total estimated landings of fish and shellfish amounted to 662.1 million pounds, with an estimated ex-vessel value of $11.5 million.

2. Menhaden, otter trawl, and surf clam fisheries account for 98 percent of total annual production. Miscellaneous minor fisheries include purse seine for foodfish, pot, pound net, drift gill net, trawl line, hand line, troll line, scallop, lobster, and sport. Of these, drift gill net, pound net, trawl line, hand line, and troll line fisheries have become of decreasing importance in recent years.

3. Menhaden is the major fishery in the region, producing over 622 million pounds, or 94 percent of the total catch, in 1953, the largest

Table 26.--Catch per unit data, party and charter boat fisheries, all New Jersey, 1952-1953

Species	1952		1953	
	Number of men	Number of fish/man	Number of men	Number of fish/man
Bluefish	452	9.4	416	8.8
Fluke	912	8.4	2,870	5.8
Mackerel	775	19.5	--	--
Porgy	1,626	23.0	1,585	18.1
Sea bass	878	16.8	1,370	12.2
Weakfish	386	12.2	154	14.6

Table 27.--Species composition in numbers of fish, southern New Jersey surf fishery, 1952-1953

Species	Percent 1952	Percent 1953
Bluefish	1.8	22.2
Fluke	0.5	8.1
Grunt		8.3
King whiting	3.8	10.8
Sea bass	12.5	
Spot	23.6	
Striped bass	8.7	
Tautog	12.2	5.3
Weakfish	26.7	39.7
White perch	9.1	
All others	1.1	5.6

catch in the history of the fishery. A purse seine fleet of 33 vessels operates from the last week in May through mid-October on grounds lying inside the 10 fathom contour between Barnegat Inlet and Ocean City, Maryland. Over the 15-year period, 1939-1953, annual production has fluctuated about a mean yield of 264 million pounds. Calculated statistics indicated a high level of availability of menhaden.

4. The otter trawl fishery for foodfish is second in importance. Production in 1953 amounted to nearly 21.0 million pounds, or about 3 percent of total landings. An inshore fleet of 66 small and medium-sized vessels fishes primarily for fluke, porgy, and weakfish inside the 15 fathom curve from May through November. An offshore fleet of 64 larger vessels fishes in deeper waters for porgy, sea bass, and fluke from October through May. Annual production for the 8-year period, 1946 through 1953, averaged approximately 17.5 million pounds. Porgy, fluke, sea bass, and weakfish accounted for about 80 percent of the total landings during the period considered. Arbitrary statistics indicated relatively high levels of abundance of fluke, porgy, and weakfish in 1953.

5. Since 1950, the surf clam has become one of the major fishery resources of the area, producing 7.7 million pounds of meats in 1953. The ex-vessel value of the catch amounted to $963,000. A dredge fleet of 46 full-time vessels operates throughout the year. The most important grounds to the fishery are located off the mouth of Delaware Bay in the vicinity of Five Fathom Bank and Five Fathom Lightship and in the area known as the "Lumps" east-southeast of Ocean City, Maryland. Over the 4-year period, 1950 through 1953, the annual yield has increased steadily. Catch per unit effort has declined, however, reaching its lowest level in 1953.

6. Two purse seine fisheries for foodfish operate within the survey area: (1) mackerel and (2) other pelagic, schooling species. The mackerel fishery is subject to violent fluctuations with no appreciable landings since 1949. A small fleet of seiners lands several million pounds of porgy and weakfish annually. Important fishing grounds are located inside the 10 fathom curve off Barnegat, Brigantine, Sea Isle City and in the vicinity of Five Fathom Bank.

7. A pot fishery produces approximately 2.0 million pounds of sea bass annually from grounds located along the 10 fathom curve.

8. Pound nets, once a major fishery, have declined in numbers. Less than 1.0 million pounds were produced by this gear within the area in 1953. Fishing areas are located immediately offshore of the 10 fathom contour between roughly Ocean City, New Jersey and Winter Quarter Lightship.

9. Combined landings of the drift gill net, trawl, troll, and hand line fisheries in 1953 amounted to only 426,000 pounds. Grounds of importance to these fisheries lie in a continuous belt from the beach to 25 miles offshore.

10. Sport or recreational fishing accounts for a relatively small portion of the landings, although it contributes substantially to the economy of the area by providing a source of income to party and charter vessels and other recreational interests. Estimated production in 1953 was somewhere between 3.0 million and 5.0 million pounds. The fishery is conducted from the beach to a distance of 40 miles offshore.

11. In 1953 there were approximately 1,975 fishermen actively engaged in the commercial and sport fisheries in the area considered.

12. Estimated replacement value of vessels and gear amounted to approximately $11.2 million.

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APPENDIX A

COMMON AND SCIENTIFIC NAMES OF FISH AND SHELLFISH

Anglerfish	Lophius piscatorius
Black drum	Pogonias chromis
Bluefin tuna	Thunnus thynnus
Bluefish	Pomatomus saltatrix
Bonito	Sarda sarda
Butterfish	Poronotus triacanthus
Cabio	Rachycentron canadus
Cod	Gadus morhua
Common eel	Anguilla bostoniensis
Conger eel	Leptocephalus conger
Croaker	Micropogon undulatus
Dolphin	Coryphaena hippurus
Fluke	Paralichthys dentatus
Grunt	Haemulon species
Haddock	Melanogrammus aeglefinus
King whiting	Menticirrhus saxatilus
Little tuna	Euthynnus alletteratus
Mackerel	Scomber scombrus
Mackerel shark	Isurus nasus
Menhaden	Brevoortia tyrannus
Pollock	Pollachius virens
Porgy or scup	Stenotomus chrysops
Red drum	Sciaenops ocellata
Red hake	Urophycis chuss
Sand perch	Bairdiella chrysura
Sea bass	Centropristes striatus
Sea herring	Clupea harengus
Sea robin	Prionotus species
Skates	Raja species
Spot	Leiostomus xanthurus
Striped bass	Roccus saxatilus
Tautog	Tautoga onitis
Tilefish	Lopholatilus chameleonticeps
Weakfish	Cynoscion regalis
White hake	Urophycis tenuis
White marlin	Makaira albida
White perch	Morone americana
Whiting	Merluccius bilinearis
Windowpane	Lophopsetta maculata
Wolffish	Anarhichus lupas

(Appendix A continued)

Blue crab	Callinectes sapidus
Conch	Busycon canaliculatum and B. caricum
Lobster	Homarus americanus
Sea scallops	Placopecten magellanicus
Squid	Loligo pealei
Surf clam	Spisula solidissima

APPENDIX B

FLEET SIZE, REPLACEMENT VALUE, NUMBER OF FISHERMEN EMPLOYED, AND VALUE OF CATCH FOR 1953.

Fishery	Number of vessels	Replacement value of vessels and gear	Number of fishermen employed	Value of catch
Menhaden	33	$ 6,300,000	957	$7,100,000
Otter trawl	86	2,850,000	285	2,000,000
Surf clam	46	920,000	130	963,000
Purse seine for Foodfish	3	200,000	24	150,000
Pot	20	200,000	40	190,000
Miscellaneous Commercial	20	100,000	40	200,000
Sport	250	1,875,000	500	900,000

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